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	PAGE
The Relation of Universities and Research Institutes to Industrial Development. GILBERT J. FOWLER	103
Bombay Fisheries. S. L. HORA	108
Letters to the Editor	109
Reviews	127
Stellar Dynamics. B. S. MADHAVA RAO ..	136
Theosophy and Science Shake Hands. R. NAGARAJA SARMA	137
Centenaries. BY S. R. RANGANATHAN—	
Regaud, Stephen Peter (1774–1839) ..	139
Colburn, Zerah (1804–1839)	139
Binnie, Alexander Richardson (1893–1917)	139
Tata, Jamsetji Naserwanji (1839–1904)	139
Astronomical Notes. T. P. B.	140
Agricultural Research in India. C. N. A. ..	141
Indian Forest Mycology with Special Reference to Forest Pathology. M. B. ..	142
Science Notes and News	143
Academies and Societies	150

The Relation of Universities and Research Institutes to Industrial Development

IN the Report of the Chemistry Research Board of the British Government Department of Scientific and Industrial Research for the triennial period ended 31st December 1937, the following statement is made in the Introduction to the Report of the Director of Chemical Research:

"During the last 3 years some 20 members of the staff in various grades have resigned to take up responsible positions in Industrial organizations dealing with different branches of chemical manufacture."

In contrast with this may be mentioned a reply given by the Director of the Government Test House, Calcutta, when the remark was made to him that no doubt many of their workers found positions in industrial concerns. The Director's reply was: "On the contrary, we have a number of applications from men holding positions in industry to be taken on to the Research staff at the Test House." This contrast would appear to be significant and to reveal conditions wherein the state of industry in India differs markedly from what exists in England. In the first place, it would seem that the young Indian scientific worker prefers the quiet atmosphere of a Research Laboratory—whether scientific or technical—to the more adventurous existence in an industrial concern. The fact that much of the Research work of the Industrial Research Bureau is carried out at the Alipore Test House would no doubt also add the attraction of Government service to even a humble position. Moreover, in many cases a University graduate will find the surroundings of a factory in India uncongenial after the peaceful atmosphere of the University or the Research Institute laboratory. He will often find no doubt that there is not much scope at present for his academic attainments. It does not require great scientific knowledge, *e.g.*, to notice where steam is escaping from faulty flanges, or where an appreciable percentage of the product of the factory finds its way on to the floors from leaky containers, but it is just this faculty of what was termed by a lady speaker at the Silver Jubilee Meeting of the Indian Science Congress "good house-

keeping", which is a preliminary requirement of success in technical industry.

On the other hand, the desire for a quiet life in a scientific atmosphere is very different from the urge which, we are told, led young W. H. Perkin to leave his Assistantship in the laboratory of the great Hoffmann in order to make a supply of his new mauve dye and to become a somewhat unsuccessful commercial traveller among the calico printers of Scotland, and finally to persuade his father to build a works and to evolve suitable processes and plant, in the first place, for the manufacture of aniline, though he (Perkin) had never been inside a chemical works before. A whole series of other difficulties—chemical and mechanical—had to be overcome before the dye industry was established and Perkin was free after 16 years to go back to his beloved scientific laboratory.

In another field of technical enterprise it is related that one of the members of the "Big Five", responsible for the installation of the "Grid" in England, in the early days of his career was so determined to become a mechanical engineer that he signed on in the engine room of a cargo steamer and braved the horrors of sea-sickness—he was a bad sailor—in order to acquire the real competency which is only to be gained by actual contact with day-to-day difficulties.

It is possible that the reason why engineers often hold more responsible positions in technical industry than do chemists is because in a majority of cases, hard workshop practice, necessitating early morning hours and the wearing of overalls, is part of the customary training of an engineer. Sir P. C. Ray has more than once spoken very frankly about the special disabilities of Indian University graduates. Dr. H. E. Watson, in a recent letter to the present writer, mentions an under-graduate course designed to act as a connecting link between the Faculties of Science and Engineering in the University of London.

On the other hand, it is doubtful whether more than a limited number of industrialists in India really appreciate the possible advantages of the application of scientific knowledge to the operations of their factory.

There need not, however, be undue discouragement. The early records of the Indian Institute of Science show that the first members of the staff were very much concerned at the lack of practical laboratory competence on the part of many of the first students. They possessed a fair amount of book knowledge, but appeared quite incapable of handling even simple experiments in the laboratory. Since those days the outturn of reasonably well qualified graduates in chemistry and physics is more than sufficient to supply available vacancies. Nevertheless, the number of those who are really in a position to take responsible posts in industry, as apart from simple positions as analysts or subordinate supervisors is still small. Complaints are still heard of the lack of what may be termed "bench craft" on the part of the average University graduate. The lack of "machine sense" and of the capacity of making intelligible drawings is also remarked by responsible people.

It would seem likely that Indian scientific education has been somewhat circumscribed and one-sided. In the early days of what was then known as "technical education" in England, the need for which was awakened in the seventies by the phenomenal progress of Germany, the appeal was made to a rather wider public than has necessarily been the case in India. Great men like T. H. Huxley and Sir Henry Roscoe lectured to audiences of industrial workers and intelligent middle class amateurs, awakening an interest in the outstanding discoveries of the science of that time, and powerfully influencing the type of education to be introduced into the elementary and secondary schools then coming into existence. It was Huxley who emphasised the educative influence of drawing. The following is taken from a volume of his "Aphorisms and Reflections":—

"I do not wish to exaggerate but I declare to you that in my judgment the child who has been taught to make an accurate elevation, plan and section of a pint pot has had an admirable training in accuracy of eye and hand."

Unfortunately in India, although no one doubts the practical manual dexterity of the Indian workman and the intelligent fitter or mistry, these men are often illiterate while the educated graduate has not acquired the practical competence of the workman. The habit of taking verbatim notes of lectures goes far to kill the real faculty of assimilation. By contrast an incident related as having happened in the early days of the Manchester Technical School, later to grow into the Manchester College of Technology, may illustrate the point. A working man took his place in an evening class and prepared to listen to the lecture. He was reminded that he had not got a note book. "What would I want a note book for?", he said. "To write down what the lecturer says", he was told. "What should I do that for?" he asked. "In case you might forget". "Wot's me blinkin' 'ed for?" was his final and sufficiently crushing response. If the education in the primary and secondary schools and in the intermediate colleges is made less academic and the aspect of craftsmanship stressed at every stage it will not be so difficult for the University and the Research Institute to take up the problem at a later stage.

At this point the difference may be emphasised between the type of work which can be usefully carried on at a University as distinct from a Research Institute. The University is concerned with general education rather than specialist investigation, at any rate of an industrial type. Nevertheless the work done at the University can be of great importance in preparing the student for his future career in industry. The subjects of "bench craft" and drawing have already been referred to. In the later stages research work of an industrial bearing, which yet can be taken up in the University without serious alterations in the syllabus and equipment, has been indicated in an admirable paper published by Dr. T. S. Wheeler in the *Journal of the University of Bombay*, Vol. I, Part II, September 1932. Dr. Wheeler shows how the various types of chemical development research may be classified broadly as follows:—

1. Production of a new product.
2. Production of an existing product by a new process.
3. The improvement of an existing process.
4. The transference of a known reaction from the laboratory to the technical scale.

He goes on to show the fundamental characteristics of new processes, *viz.*, the ready availability of raw material and the control of external conditions particularly pressure, temperature and electrical external conditions. The problem of the transference of a known reaction from the laboratory to the technical scale is intermediate between the task of the University and of the Research Institute or the actual factory. Even here experiences which have been related by several of those who have delivered the Streatfield Memorial Lecture under the auspices of the Institute of Chemistry have testified to the success of the homely methods employed by Streatfield at the Finsbury Technical College to awaken "technical sense" amongst his students. Thus we are told that one of the exercises given to them was the distillation of 2 or 3 gallons of coal tar separating the various fractions and preparing specimens of as many substances as could be isolated. The distillation was carried out with a small scale iron retort in a room downstairs. Almost invariably a too rapid heating during the initial stages resulted in an uncontrollable frothing when the water began to boil. Streatfield did not forget to point out the moral which the necessary cleaning up made unforgettable.

In the University may, and should be instilled, those qualities of *character* which

are essential for success in any technical enterprise of moment. It is sometimes forgotten by the academically-minded that success in the honest development of a great productive business calls for qualities equal to or even more admirable than those developed by scientific research. This is rightly recognised in Government Honours Lists and even, of late years, by such a body as the Royal Society. It has been pointed out by responsible authority that the practical working out of a new process, while it may not result in many publications in scientific literature, yet calls for an equal or even greater truly scientific ability. Moreover, such work inevitably entails the development of the team-spirit, the need for which among scientific workers has been eloquently referred to in the Presidential Address of Dr. J. C. Ghosh before the Lahore meeting of the Indian Science Congress.

The importance of the cultivation of the *inventive* faculty has been stressed by the present writer in another connection.* How far opportunities for the cultivation of this faculty are multiplied will depend very largely on the experience and personality of the teacher. A danger which besets the graduate whose training is confined to the University is a tendency to a purely laboratory outlook. It has been fairly argued that in India owing to the fewness of manufacturing centres and the great distances between them it is very difficult for many University students to visit actual factories. With the modern development of the cinema it should be possible without too great expense to exhibit to even elementary classes, films illustrating fundamental technical processes more vividly than the old-fashioned diagram or model.

The Research Institute differs from the University in the fact that it is concerned as a rule with the study of a single industry or at most of one or two. It is, therefore, possible for much greater expenditure to be incurred in equipping the specialist department with the plant necessary to carry out technical work on a scale, at any rate approaching that of the actual factory. India has been fortunate in the multiplication of such Institutes of recent years, Iron and Steel can be studied at Jamshedpur, Fuel at Dhanbad, Sugar and Oil at Cawnpore, Electrical Technology at Bangalore and Lac at Ranchi. These centres are mentioned as being concerned with technological rather than techno-agricultural research such as the several institutions sponsored by the Imperial Agricultural Research Council.

Government has been criticized for not having shown the same generosity towards Technological Research as in the case of agricultural investigations. It would seem, however, that the work already done and still being pursued by the Industrial Research Bureau, working under the guidance of the Imperial Industrial Research Council, has not been sufficiently recognized. In the first place and at the outset of its work an admirable bibliography of industrial publications was compiled and is available at the Government Press. In addition, no fewer than 13 valuable Bulletins dealing with such subjects as the Indian Glass Industry, Manufacture of Photographic plates in India, the Development of Heavy Chemical Industries in India as well as several important aspects of the Oil and Soap Industry have been published. The Bureau, it may be remembered, has only been actively at work during less than 4 years. The laboratories of the Industrial Research Bureau are being continually extended and work of great importance is in progress concerned particularly with standardisation of manufactured articles, the testing of liquid fuels in engines, the study of the weather-resisting properties of paint products and the manuacture of dry cells. Important work has been undertaken in connection with the glass industry, involving the design and operation of a special furnace.

* Address to the Institution of Chemists (India) entitled: "Research and Invention" on 26th August 1938. *Proceedings of the Institution of Chemists (India)*, Dec. 1938, **10**, Pt. IV.

There is no doubt, however, that the work of the Bureau could be greatly developed if sufficient funds were provided to enable it to extend its area of usefulness in *liaison* with the Universities and the Research Institutes. In a recent lecture on Research in the Iron and Steel Industry, published by the Institute of Chemistry, Dr. W. H. Hatfield, F.R.S., gives a table showing the number of official organizations co-operating with the Research Council and Research Committees. There are nearly thirty of these organisations including four Universities and several University Colleges and a number of Professional Institutions and Research Associations.

It is doubtful whether it is fully recognized, either by those in financial authority or by would-be *entrepreneurs*, that the development of a new industry or even of a new process entails usually the expenditure of very large sums of money. Even those who were closely associated with Ludwig Mond in the early days of the Brunner-Mond Works at Winnington, Northwich, were sometimes almost appalled at the way in which he would scrap an expensive plant and build another if he saw that certain lines of investigation were not worth pursuing. The amount of money necessary to be expended before the simple laboratory apparatus, in which nickel-carbonyl was first prepared, could be developed into the plant of the Mond Nickel Company, must have been enormous. That is why even in the laboratory exercises of a University course, attention should be paid to the question of yield of product and the prevention of wastage at every stage. There is no doubt also that those who are to take their place in technical industry should, at some stage of their early career, have a fairly rigorous training in business methods and fundamental economics.

However near the technical laboratories of the University or the Technological Research Institute may approach to real factory conditions, they can never be a substitute for real experience in the actual world of industry. It is possible, however, although not always easy of accomplishment, to create as we have seen in the case of the Iron and Steel Industry just quoted a close connection between the University or the Research Institute, and the industrial concern. This is easier if the industry is more or less of a public character or if the technical problems to be investigated are concerned with activities natural to a Government or Municipality. Thus in Manchester, the Electricity Department and the Rivers or Sewage Purification Department of the Corporation maintained close touch with the University laboratories to their great mutual advantage. The beginnings of such co-operation are already evident in India as has been mentioned in a former article in *Current Science*.† Where possible, the teaching staff in a Research Institute or in the Technological Department of a University should be recruited from those who have combined both academic training and practical and responsible experience in the industrial world.

On the foregoing lines existing institutions in India may play their valuable part in helping forward the industrialisation which, it is generally agreed, is necessary if the future growth of the new Indian nation is not to be one-sided or limited.

It must, however, always be remembered that the urge to industrial development in the West derived its original impulse mainly from individual men of genius and vision. India also owes much to such men as Jamsetji Tata, Sir P. C. Ray and their associates. Soon it may be hoped that the facilities provided by the generosity of Laksmi Narayan and other wealthy benefactors will also bear fruit. The fulfilment of the great ideas present in the minds of such pioneers will require the loyal and keen enthusiasm of younger India and the support of widely diffused and intelligent public opinion.

GILBERT J. FOWLER.

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† "Water Pollution Research," *Curr. Sci.*, January 1939, pp. 3–5.

Bombay Fisheries

REGULAR readers of this *Journal* are no doubt familiar with the establishment, a few years ago, of a small Fisheries Section of the Department of Industries in the Presidency of Bombay with the main object of augmenting the fish supply of the town of Bombay by the use of motor launches. Under the able guidance of Dr. S. B. Setna, the Fisheries Section has made rapid progress and the scope of its working has gradually been widened. The *Annual Report* of the Department of Industries, Fisheries Section, 1937–38, recently published, shows the many-sided activities of this young department. The number of motor launches now in use for fish trade is 8, 4 belonging to the Department and the others privately owned. The bulk of the catch transported by these launches is obtained from the Karwar and Chendia which are about 270 and 290 miles respectively away from Bombay. The great utility of the launches in the fish trade will be evident from the fact that "This fish would not have come to Bombay without the launches but would have gone to the fish curing yards thereby reducing a first class edible commodity to a third rate product lacking in food value. Fish either salted or converted into manure would have fetched about five or six thousand rupees whereas in the fresh state it realised in Bombay about Rs. 60,000. This is an immense gain to the fish trade".

In the Report attention is directed to the fishing season and the quantities of fish brought by launches, to the needs for modern fishing methods, to the lack of suitable fish landing sites and to the need for the establishment of a marine biological station and an aquarium for research in fishery problems. Progress is reported in the training of apprentices to handle and operate the launches and in the establishment of new ice factories.

In the account of the fish curing yards attention is directed to the number of the yards, to the kind of fish cured at the yards, and to other varied aspects of their management.

Several experimental measures adopted for the improvement of freshwater fisheries are enumerated, and the success or failure that attended these measures is clearly indicated. The rapid growth in the size of *Catla* and *Gourami* in the Bombay waters is very encouraging, as both the species are good for stocking tanks. The proposal to stock certain ponds with *Murrel* fry is, however, full of danger, as the fish is a well-known predaceous form, and is likely to do considerable damage to the indigenous fish-fauna, if any, of these ponds.

The Fisheries Section also rendered considerable help to the Angling Association in the stocking operations at Powai Lake, and acted as the bureau of fishery information for attending to enquiries on a variety of subjects from the general public, and the Provincial and State Governments.

S. L. HORA.

LETTERS TO THE EDITOR

	Page
A Note on the Kinetic Theory Expression for the Viscosity of a Gas. By K. S. Gururaja Doss	109
A Note on the Effect of Finite Breadth of the Hammer Striking a Pianoforte String. By D. Basu	109
The Origin of the Tetraploid Nicotiana from Bathurst. By Dontcho Kostoff	110
Embryological Evidence for the Relationships of the Lythraceæ and Related Families. By A. C. Joshi	112
Aceto-Carmine Smear Technique for Cotton Cytology. By D. Ganeshan	114
Hairiness of the Midrib Edges in Sorghum. By G. N. Rangaswami Ayyangar and B. W. X. Ponnaiya	115
The Occurrence and Inheritance of Panicle-tip Sterility in Sorghum. By G. N. Rangaswami Ayyangar and B. W. X. Ponnaiya	116
Grafting of Apple on Eriobotrya Japonica *Stocks.* By M. J. Thirumalachar	118
A Terrestrial Species of Oedogonium. By M. S. Randhawa	118
A Note on the Gametophyte of Botrychium virginianum *var.* lanuginosum, *SW.* By L. Narayana Rao	119
Eugenia jambolana. By N. V. Subba Rao and T. R. Seshadri	120
Effect of Colchicine on Plant Cells. By B. N. Singh, S. Sampath and R. K. Bansal	121
Koleroga Disease of Areca Nut. By B. N. Uppal and M. K. Desai	122
A Re-description of Lemdana marthæ *Seurat, 1917.* By M. B. Mirza	124
Identity of Two Important Parasites hitherto considered as Distinct Species. By K. B. Lal	125
Research Work on the Hilsa. By D. W. Devanesen	126

A Note on the Kinetic Theory Expression for the Viscosity of a Gas

By an elementary application of the kinetic theory, the expression for the viscosity of a gas works out to be $1/3\ nmc\bar{}\ \lambda$ where n is the number of molecules per c.c., m is the mass of a molecule, $c\bar{}$ the mean velocity and λ the mean free path. This expression is approximate and differs from the accurate expression proposed by Chapman[1] by a numerical factor. A modified elementary procedure is suggested herein, which leads to an expression practically identical with that of Chapman. In the elementary derivation of the formula for viscosity, it is assumed that the number of molecules crossing a unit area from a lower layer to an upper layer (and *vice versa*) in one second is equal to $1/6\ nc\bar{}$. If one replaces this approximate expression by the correct one, *viz.*, $n\sqrt{\frac{RT}{2\pi M}}$ (where R is the gas constant, T is the absolute temperature and M the molecular weight), the final expression for viscosity is found to become,

$$\frac{1}{\pi}\sqrt{\frac{MRT}{\pi}}\cdot\frac{1}{Nd^2} \text{ or } 0{\cdot}3185\sqrt{\frac{MRT}{\pi}}\cdot\frac{1}{Nd^2}.$$

where N is the Avogadro number and d is the diameter of the molecule. The accurate expression for viscosity derived by Chapman is

$$\frac{5\times 1{\cdot}018}{16}\sqrt{\frac{MRT}{\pi}}\cdot\frac{1}{Nd^2} \text{ or } 0{\cdot}3175\sqrt{\frac{MRT}{\pi}}\cdot\frac{1}{Nd^2}.$$

A comparison of the two formulæ shows that by the modified procedure suggested herein, the expression obtained is practically identical with that got by Chapman, the difference between the two being barely 0·3%.

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March 1, 1939.

[1] *Phil. Trans.* (A), 1916, **216**, 337.

A Note on the Effect of Finite Breadth of the Hammer Striking a Pianoforte String

In a theoretical paper (*Bull. Cal. Math. Soc.*, 1937, **28**, 187) it has been shown by me that the finite breadth of the hammer has an effect on the duration of contact. In the said paper duration of contact Φ is given by

$$\Phi = \pi\sqrt{\frac{M(a-b)}{T_1}},$$

where M stands for the mass of the hammer, a for the length of the shorter segment of the

string measured from the mid-point of the struck portion, b for half the length of the contact and T_1 for the tension of the string. As in none of the previous experiments by other workers could this result be checked, fresh experimental study of the problem has been made by the standard photography-method.[1] The camera slider with the paper facing upward moves horizontally along the groove of a massive wooden piece; a rigid pendulum, at the end of which glass projectors of lengths ranging from 0 to 3 cm. are clamped, serves as the hammer; a carbon arc lamp illuminates a fine slit vertically down; a long tuning fork of frequency 100, gives delicate wave traces of considerable length and amplitude thus admitting high precision in time-recording; the slider moves under the weight of a mass and as it moves its other end drags a ball through water contained in a long vertical chamber to ensure constancy of velocity; the photographic paper passes under the illumined slit only during the interval from the time the hammer begins to strike the string to the time the hammer leaves it,—such synchrony being achieved by means of an electromagnetic automatic operator. The final photographs are measured with the help of a long-focus travelling microscope. As M, in the present case of a rigid pendulum, is tedious to find, the durations of contact are expressed as ratios of Φ_0—the duration when $b = 0$.

$a = 10$ cm.

Length of contact	$\frac{\Phi}{\Phi_0}$ (Experimental)	$\frac{\Phi}{\Phi_0}$ (Theoretical)
1·0 cm.	0·985	0·974
2·0 ,,	0·970	0·948
3·0 ,,	0·957	0·922

There is an agreement in the order of magnitude but the experimental results show the decrease of Φ with the increase of b to be smaller than what the theory predicts. A detailed analysis together with the effect of curved hammer is in progress and will be published elsewhere in due course.

I take this opportunity to acknowledge my indebtedness to my father Mr. K. K. Bose, M.A., for facilities he has offered to me to carry out this work and also to Prof. K. C. Kar, D.Sc. for his keen interest in the same.

D. Basu.

Prativa Physical Laboratory,
Burdwan,
January 27, 1939.

[1] M. Ghose, *Ind. Jour. Phys.*, 1932, **7**, 365.

The Origin of the Tetraploid *Nicotiana* from Bathurst

In 1936 I received seeds from Dr. H. Wenholz, Australia, of Australian tobacco species. One package was labelled as "Wild tobacco, *Nicotiana* sp., Coll. R. G. May, Bathurst, N.S.W., immune or highly resistant to Blue mould, *Perenospora tabacina*". In the list of tobacco species sent kindly to me by Dr. Roy E. Clausen, California, *Nicotiana suaveolens* from Bathurst with doubled chromosome number ($n = 32$) was included. The plants that grew from the seeds sent to me by Dr. Wenholz originating from Bathurst were in many respects similar to *Nicotiana suaveolens* Lehm., and fit to the description given by Wheeler (1936) for the tetraploid *N. suaveolens* from Bathurst. They had 64 somatic and 32 gametic chromosomes, which means that they were tetraploids in respect to the Australian species having $n = 16$. A large number of Australian tobacco species as for example *N. suaveolens, N. maritima, N. velutina, N. excelsior,* etc., have 16 gametic and 32 somatic chromosomes.

Tetraploid *Nicotiana* species from Bathurst grew very vigorously. In favourable conditions it reached in height of about 180 cm., while *N. suaveolens* Lehm. in the same conditions reached a height of ca. 70–90 cm. The flowers of the tetraploid species were in many respects like those of *N. suaveolens*, the leaves were, however, much larger, somewhat broader and with uneven surface. The flowers of *N. suaveolens* have a very agreeable odour, while those of the tetraploid *Nicotiana* smell disagreeably like the flowers of *N. maritima*, though not as sharp as those of the latter species. The capsules of the tetraploid species are similar to

the capsules of the F_1-hybrids *Nicotiana maritima* × *N. suaveolens*.

In studying the meiosis of the tetraploid form I found usually 32 bivalents, though occasionally one quadrivalent or one trivalent and one univalent were also found. It was of importance from an evolutionary point of view to determine the mode of origin of this tetraploid form.

If we provisionally assume the number 16 for basic chromosome number for the *suaveolens—maritima—velutina* group of the Australian tobacco species, our tetraploid *Nicotiana* has then the genom formula *S S Sx Sx*. The fact that occasionally quadrivalents and trivalents were found during the meiosis of the tetraploid *Nicotiana* from Bathurst, suggested that certain chromosomes of *S* genom are homologous or have homologous segments with the chromosome of *Sx* genom. In order to determine, however, more definitely the degree of homology of *S* and *Sx* genoms, we crossed the tetraploid *Nicotiana* from Bathurst with the American tobacco *Nicotiana sanderæ* ($n = 9$, $2n = 18$). The hybrids between *N. sanderæ* and the Australian species are usually characterized with asyndetic meiosis. During the first meiosis in these hybrids usually 25 univalents were found, though one or two (rarely) bivalents sometimes also occur. The F_1-bivalents, the 9 univalents being *N. sandaræ* formed usually 16 bivalents and 9 univalents, which shows that *S* genom is homologous to *Sx* genom since the chromosomes of these two genoms conjugated (autosyndesis) forming 16 bivalents, the 9 univalents being *N. sanderæ* chromosomes.

I attempted further to investigate the degree of differentiation of genom *S* in respect to genom *Sx*. Autosyndesis in F_1—*Nicotiana* from Bathurst × *N. sanderæ* showed that *S* genom is closely related to *Sx*, but these observations were not sufficient to answer the question as to whether *Nicotiana* from Bathurst is an autotetraploid or whether it is an allotetraploid from very closely related forms, the chromosomes of which conjugate during the first meiosis in their F_1-hybrids. In studying the procedure of the first and second meiotic anaphases and telophases in F_1-hybrids between tetraploid *Nicotiana* and *N. sanderæ* I found, that in some cells, chromatin bridges were formed. The formation of chromatin bridges during the meiotic anaphases suggested that the chromosomes of *S* genom are structurally not identical in respect to the chromosomes of genom *Sx*, the structural differences being of the type of inversions. This statement, although being of importance from a cytogenetic point of view, it does not decide the question of the autopolyploid or allopolyploid origin of the tetraploid form since the structural changes that characterises *S* and *Sx* genoms might as well have taken place until or after the chromosome doubling. The morphological and the cytological behaviour of the tetraploid species from Bathurst, the Australian species of the group *Nicotiana suaveolens—maritima—velutina* and the species hybrids *N. maritima* × *N. suaveolens*, *Nicotiana* from Bathurst × *N. suaveolens* and *N. suaveolens* intraspecific hybrids, suggested that the tetraploid *Nicotiana* from Bathurst has originated by chromosome doubling in F_1—*N. maritima* × *N. suaveolens* hybrid or in a *N. maritima—N. suaveolens* segregate. It should be mentioned here that F_1-hybrids *N. maritima* ($n = 16$) × *N. suaveolens* ($n = 16$) have almost normal meiosis, forming usually 16 bivalents and are fully fertile. Morphological appearance of the F_1—*maritima* × *suaveolens* hybrids is, in many respects, similar to that of the tetraploid *Nicotiana* from Bathurst. Disagreeable odour of the flowers of *N. maritima* dominates in F_1-hybrids which accounts for the presence of the same character in the tetraploid species. The odour of *N. maritima* flowers is, however, much more disagreeable than that of the tetraploid *Nicotiana* from Bathurst and of the F_1-*maritima suaveolens* hybrids. *N. suaveolens* is resistant to most of the virus diseases from which our tobacco species in Moscow suffer. *N. maritima* is very susceptible, while the tetraploid *Nicotiana* and the F_1-hybrids *N. maritima* × *N. suaveolens* are less resistant than *N. suaveolens* and less susceptible than *N. maritima*. The flower

shape of the tetraploid *Nicotiana* is similar, though it is not identical with that of the flowers of the F_1-hybrids *N. maritima* × *suaveolens*. Such deviations, however, are to be expected for the following three reasons: (1) They can be due to crossing-over and further to segregations in the allopolyploid *N. maritima–suaveolens*, since allopolyploids originating from F_1-hybrids with allosyndetic meiosis always segregate (*cf.* Kostoff, 1938*a*). (2) Chromosome doubling in plants ultimately leads to a series of changes in all the plant organs including the flowers (*cf.* Kostoff, 1938*b*, *c*, *d*). (3) Accumulations of new hereditary changes in the newly originated tetraploid and eliminations of the less fitting forms by natural selection. I shall also mention here that the areas of distribution of *N. suaveolens* Lehm. and *N. maritima* Wheel. overlap each other in South Australia.

The hybrids between the tetraploid *Nicotiana* from Bathurst and *N. suaveolens* Lehm. are highly sterile, being "triploids" and set occasionally very few seeds. The morphological appearance of the tetraploid *Nicotiana* from Bathurst, its physiological characters and cytogenetic behaviour give us sufficient background to separate it into a *species nova* which has originated by chromosome duplication in a hybrid and shall call it *Nicotiana eastii*. It is cytogenetically more isolated from *N. suaveolens* and *N. maritima*, than the latter two species amongst each other because the species *N. suaveolens* and *N. maritima* cross easily and their hybrids are fully fertile, while *N. eastii* does not cross so readily with *N. maritima* and with *N. suaveolens* and its hybrids with these two species are highly sterile.

DONTCHO KOSTOFF.

Academy of Sciences, U.S.S.R.,
Moscow,
March 1, 1939.

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Embryological Evidence for the Relationships of the Lythraceæ and Related Families

HUTCHINSON (1926) in his recent classification of the Dicotyledons has made a great departure in the systematic position of the Lythraceæ and related families from that usually assigned to these in the older systems. Bentham and Hooker (1862–83), Engler and Gilg (1924), Bessey (1915) and Wettstein (1924) have all placed the families Lythraceæ, Sonneratiaceæ and Onagraceæ along with families like Myrtaceæ and Combretaceæ in the order Myrtales (or Myrtifloræ). Hutchinson completely disregards this generally accepted view, and places the former families quite apart from the latter in a separate order Lythrales. This order, including Lythraceæ, Crypteroniaceæ, Sonneratiaceæ, Punicaceæ, Oliniaceæ, Onagraceæ, Halorrhagaceæ and Callitrichaceæ, is derived by him from the Caryophyllales through the sub-family Sileneæ, while the Myrtales, including only the families Myrtaceæ, Lecythidaceæ, Melastomaceæ, Combretaceæ and Rhizophoraceæ, is supposed to represent the epigynous forms of the Theales and some Tiliales.

During the last five years the writer has been closely associated with several investigations on the embryology of both the Centrospermæ, which includes the order Caryophyllales of Hutchinson, and Lythraceæ and Sonneratiaceæ. The data obtained from these investigations appear to throw definite light on the supposed relation between the Caryophyllaceæ and the latter families.

The Caryophyllaceæ have certain characteristic embryological features. The mature pollen, as Schnarf (1931) says, is tri-nucleate. Its form, as known from *Arenaria*, *Silene* and *Dianthus*, is that of a pentagonal dodecahedron (Kerner and Oliver, 1895). There are as many germ pores as the faces of the grain. The ovule is always more or less campylotropous (Gibbs, 1907; Rocén, 1927; Woodcock, 1926 and 1928; Joshi, P. C., 1936). The micropyle is formed only by the inner integument. The nucellus is capped by several layers of cells

formed by periclinal divisions in the epidermis (Souèges, 1922).* The development of the embryo-sac corresponds to the *Normal*-type. The antipodals degenerate early (Schnarf, 1931), though in some other families of the Centrospermæ they persist up to the time of fertilisation or even afterwards (Joshi, 1936*b*), and may even multiply (Maheshwari, 1929; Bhargava, 1932; Kajale, 1937*b*). Diverticula commonly arise from the embryo-sac. After fertilisation the embryo-sac assumes an annular form. The embryo development corresponds to what has been designated as the *Caryophyllaceous*-type (Souèges, 1922). The embryo proper in this case develops from more than one cell of the filamentous proembryo and the basal cell formed by the first transverse division of the oospore never divides further. It becomes greatly enlarged and haustorial. The endosperm is present in the mature seed as a cap of cells over the radicle, and, as is well known, the mature embryo is annular and surrounds a central mealy perisperm (Rocén, 1927; Woodcock, 1926 and 1928).

The Lythraceæ (Joshi and Venkateswarlu, 1935*a*, 1935*b* and 1936) agrees with the Caryophyllaceæ in the development of the embryo-sac and in the early degeneration of the antipodals. In all other characters it is markedly different. The ellipsoidal-spherical pollen grains possess only three germ pores arranged in an equitorial manner. They are two-nucleate at the time of shedding. The generative nucleus divides into two male nuclei in the pollen-tube only just before fertilisation. The ovule shows absolutely no signs of campylotropy. It is generally anatropous. The micropyle is formed by both the integuments. The nucellus is not covered at its apex by any epidermal cap, but generally shows a hypostase below the chalazal end of the embryo-sac. There is no formation of any diverticula from the embryo-sac. The embryo development corresponds to the *Capsella*-type. The structure of the mature seed is also quite different. There is neither any perisperm nor endosperm. The embryo is quite straight.

The family Sonneratiaceæ agrees in most of its embryological characters with the Lythraceæ (Venkateswarlu, 1937), and the Onagraceæ, although it differs in the development of the embryo-sac, agrees in other respects with the Lythraceæ. It has certainly no characters common with any of the Caryophyllales. On the other hand, as Tischler (1917), Mauritzon (1934) and Joshi and Venkateswarlu (1936) have indicated, the *Oenothera*-type of embryo-sac can be derived from that of the Lythraceæ.

The above embryological studies thus indicate quite clearly that Lythraceæ and allied families are not closely related to the Caryophyllaceæ as suggested by Hutchinson (1926). For the present it would be better to keep them along with the other families of the Myrtales.

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Benares Hindu University,
January 20, 1939.

* Rocén disagrees with Souèges in this respect, but from what is known of other Centrospermæ (Joshi, 1936*a*; Joshi and Rao, 1936; Kajale, 1937*a* and 1938; and the literature cited in these papers) the writer thinks Souèges' observations to be quite correct.

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Aceto-Carmine Smear Technique for Cotton Cytology

SKOVSTED[1] refers to difficulties encountered by several authors, including himself, in obtaining good fixation and staining of the meiotic stages in cotton, by the paraffin embedding method; and advocates an improved technique to overcome the difficulties. The aceto-carmine smear technique, in spite of the ease and rapidity of the method, has not been so far widely applied in the study of cotton chromosomes except by Longley,[2] and Webber.[3,4] This method was tried at this Institute, and it was found that very excellently fixed and stained chromosomes in the pollen-mother cells of cotton could be obtained following the technique recommended by Longley and Webber with slight improvements. Figs. 1 and 2 are photomicrographs

FIG. 1.

Photomicrograph of side view of metaphase I in the P.M.C. of *Gossypium arboreum* var. *neglectum* forma *bengalensis*. × 900

FIG. 2

Photomicrograph of diakinesis in an inter-specific sterile hybrid (F_1) in a cross between *G. hirsutum* and *G. herbaceum*. × 900

of cotton chromosomes fixed and stained by this method. The following description of the method for obtaining successful results is given in the hope of its usefulness, particularly, to cotton workers in India.

In the preparation of the aceto-carmine it was found that irrespective of the brand, only when a *fresh stock* of carmine powder was used that the staining was good. No iron need be added to the aceto-carmine if only the diakinesis and the later stages are to be studied. For the earlier stages, the addition of slight traces of iron helps to stain the thin threads more deeply. A rough idea of the length of the buds showing the meiotic stages is got by measuring the buds with a seed-measuring apparatus previous to examining their anthers and after stripping off the bracts and cutting off the pedicel at the point of insertion of the calyx. With slight variations, this length is more or less constant for any particular species of cotton. For the local cotton, *Gossypium arboreum* var. *neglectum* forma *bengalensis* that has been examined, this length is about 5·5 mm. For the F_1 hybrid referred to (Fig. 2) it is about 6·3 mm. The right stage of the bud to be fixed can be determined by crushing one of its anthers under aceto-carmine, when the pollen-mother cells with their thick glistening walls can be seen loosely scattered. Fresh pollen-mother cells of cotton do not stain properly, though a few cells show the chromosomes fairly well stained. After the removal of the perianth parts the buds are fixed for about 1–2 hours in Carnoy's fluid, and transferred to absolute alcohol in which they are allowed to remain for about a day. The buds are then transferred to 80% alcohol and stored for future examination. When it is desired to study the chromosomes, 3 or 4 anthers from a bud are crushed under aceto-carmine by pressing on the cover-glass. The cover-glass is then slightly raised on the sides to let in the aceto-carmine that has flown out when applying the pressure. The slide is allowed to remain as such for 20–30 minutes. Examining the slide after this under the microscope, will show that though the chromosomes are well stained, the

cytoplasm is densely stained too. The slide is then warmed by passing it over a bunsen or alcohol flame, a few seconds at a time. The heat destains the cytoplasm alone completely, and this should be carried to the right stage by examining the slide now and then under the microscope, and applying more heat if necessary. The aceto-carmine should not be allowed to boil. The edges of the cover-glass are then sealed with Canada balsam or melted paraffin. The slides thus prepared are fresh enough for study, for about a week.

In conclusion I wish to thank Mr. Ramiah, M.B.E., Geneticist and Botanist, for suggesting the problem and for his help in the preparation of the note.

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Indore,
February 3, 1939.

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[2] Longley, A. E., *Journ. Agr. Res.*, 1933, **46**, 217.
[3] Webber, J. M., *Ibid.*, 1934, **49**, 223.
[4] —, *Ibid.*, 1935, **51**, 1047.

Hairiness of the Midrib Edges in Sorghum

In the sorghum plant whose stalks, leaves and leaf-sheaths form a good fodder, it can be said that there is practically an absence of hairiness in almost all the parts. The *Para-Sorghums* are however characterised by markedly villous nodes and leaves with stray long hairs on them. The *Eu-Sorghums* do not have this character and could be said in general to have smooth stems and leaves. Vestiges of hairiness are however met with. All sorghums have a felt of hairs on the upper side of the auricle, the triangular specialised junction, joining up the leaf-sheath and the leaf-blade. In addition to this, the commonest place at which hairs occur is the nodal band, the soft greenish tissue at the base of leaf-sheath and above the actual node. When hairs are present here, the lower sides of the felty auricular triangular areas are usually hairy. When the nodal band is hairy, it has been noted as a sure guide to the hairiness of the glumes (Ramanathan[1]). But this has not always been the case. It looks more a case of close linkage than the same gene operating in two different places. There are types with hairy nodes and glabrous glumes and *vice versa*. When the glume is hairy, the junctions of the primary and secondary panicle branches tend to be hairy also. The above are the common types of hairiness in sorghum, slender though the hairiness be.

In addition to these, special manifestations of hairiness are also met with. The occurrence and inheritance of one of these is described here.

In this type there occurs a row of hairs on either side of the midrib-groove towards the lower half of the leaf. The hairs are about 1 mm. long and they bend up one on the other towards the tip side. In addition to their presence on either side of the midrib-groove, they occur on the parallel veins in the blade area on either side of the midrib. On these veins they are confined to the very basal inch or two, and even here they appear less and less on the veins as they go towards the edges —so much so, this hairy midrib character is virtually hairiness on a zone in the neighbourhood of the ligular process (including the very base of the midrib) with a thrust of a double row of hairs on either side of the midrib for about half its length. This delicate character is best manifested on the flag and gets less pronounced in the lower leaves until at about the sixth leaf from the top it is difficult of detection. The two rows of midrib hairs being hyaline and adpressed are best noted in the juicy stalked plants, against the dull colour of the midrib of their leaves. They are not so readily spotted in the pithy stalked white midribbed leaves.

The wild rhizomiferous *Sorghum halepense* (Linn.) Pers. manifests this character to a certain degree. The cultivated non-grain sorghums *S. dochna* var. *irrungu* (Burkill) Snowden (the Irungu cholam of South India) and *S. Dochna* var. *technicum* (Koern.) Snowden (Broom corn) have a few types with a slight manifestation of this character. It is

only in the African kafirs (*S. caffrorum*, Beauv.) that this character is distinct and common.

Seeds of the variety, *Nhorongo Neupe*, were received through the courtesy of Kew from the Tanganyika territory. This variety belongs to *S. caffrorum*, Beauv. var. *Neesii* (Koern.) Snowden. A selection from this, *viz.*, A.S. 4637, showed this hairy midrib character very prominently. It is remarkable that along with this hairiness it was also noted to have a rhizomiferous tendency—a concurrent manifestation of two primitive characters. A number of selections were carried forward from A.S. 4637 and these included two, *viz.*, A.S. 5471 and A.S. 5472, which were suspected to be natural crosses as they had white midribs as against the family character of dull midrib in A.S. 4637. The two selections were, as expected, found to segregate as follows:—

Selection Number	Hairy midrib edges		Non-hairy midrib edges	
	White	Dull	White	Dull
A. S. 5471 ..	84	28	30	9
A. S. 5472 ..	74	25	24	10
TOTAL ..	158	53	54	19
Expected (9:3:3:1)	159·75	53·25	53·25	17·75

$X^2 = 0·12$ $P > ·98$

It is obvious that the hairy midrib character is independent of the dull midrib character (juicy stalks). Owing to the ease of pursuit of this hairy condition on a dull midrib background, a third generation consisting of six hairy dull-midrib selections, was carried forward from A.S. 5472, one of the above F_2 families. The F_3 behaviour is given below.

It will be seen that the midrib edge hairy character, to which is given the genic symbol MD^H is a simple mono-genic dominant to the hairless condition (MD_h). The pairs of genes MD_H and MD_h are independent, in inheritance, of X and x, the pairs of genes responsible for

A.S. 5472—F_3 Selections

Selection Number	Character of Selection	Progeny Behaviour	
		Hairy midrib edges	Non-hairy midrib edges
A. S. 6341 ..	Non-hairy	..	Pure
A. S. 6342 ..	,,	..	Pure
A. S. 6338 ..	Hairy	Pure	..
A. S. 6339	,,	Pure	..
A. S. 6337 ..	,,	58	18
A. S. 6340 ..	,,	83	28
TOTAL ..		141	46
Expected (3 : 1) ..		140·25	46·75

$X^2 = 0·014$ $P > ·90$

the manifestation of white and dull midribs in sorghum leaves (pithy and juicy stalks[2]).

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February 16, 1939.

[1] *Jour. Madras Agric. Students Union*, 1924, **12**, 1.
[2] *Madras Agric. Jour.*, 1936, **24**, 217.

The Occurrence and Inheritance of Panicle-tip Sterility in Sorghum

THE sterility of the tips of the earheads of the rice plant has been noted. Earheads with this character have been called "spongy".[1] The heritability or otherwise of this character has not been worked.

In the cultivated sorghums which are pre-eminently single-stalked, sterility of the tips, even when it does occur, has hardly any chance of perpetuation and survival as this kind of sterility can be easily spotted and the defect gradually eliminated through vigilant selection. This defect is not evasive like the sterility brought about by empty anther sacs.[2]

Mtama is a variety of sorghum belonging to *Sorghum conspicuum* Snowden, seeds of which were received from the Tanganyika territory

through the courtesy of the Royal Botanic Gardens, Kew. This variety has a very long duration (140 days) and its earheads are very long and tapering, with long lateral branches in the lower whorls. When a single-plant selection, A.S. 4680, was raised and multiplied from this variety it was found that most of the plants had earheads in which the tips of panicle branches ended bare and blunt. Next year, when the earheads were examined close on emergence from the boot, it was found that a few spikelets at the tip of both the primary and secondary branches were devoid of contents, being mere whitish scales, which on the maturity of the panicle, dried up and snapped and dropped off along with bits of dried panicle branches attached to them. Among the population of such sterile tipped earheads there occurred a few plants which, while being like the mother type, differed in having panicle branches whose tips were normal. They were suspected to be natural crosses with sister types of *S. conspicuum* and one such natural cross was carried forward as A.S. 5478. It segregated giving 125 plants with normal panicles and 41 with panicles having sterile tips. Six selections were carried forward from this F_2 generation, four of them being normal and two with panicle branch tips sterile. The two recessive bred true to the character of tip sterility and out of the four normal panicles, two segregated. One of them, A.S. 6345, gave 65 normal and 21 tip sterile panicles, and the other, A.S. 6346, gave 85 normal and 30 tip sterile panicles. In families with sterility, the percentage of sterile tipped branches varied from 80 to 90 per head. The sterility is more pronounced in the top whorls of the panicles and in stray acute cases, tips of the central axis were laid bare (see illustration). An analysis of the normal and sterile panicles was done on five heads in each. It was noted that the primary and secondary branch lengths were an average of 14·5 and 4·0 cm. respectively in sterile tipped panicles, as against 17·5 and 6·5 cm. in the normal panicles. There was also a reduction in the total number of normal sessile spikelets, there being about 800 spikelets in the sterile as against over twice that number in normal panicles. Although the panicles were affected, the plants were otherwise normal in height, diameter of internode and in number and size of leaves.

Normal Tip-sterile

Sorghum Panicles

This Tip Sterile character has been met with, for the first time, in sorghum and it has been constant in manifestation in pure lines during the past three generations. A gene designated PA_{ts} is responsible for panicles with sterile tips. PA_{TS} produces normal panicles. PA_{TS} is a simple monogenic dominant to PA_{ts}.

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February 17, 1939.

[1] *Curr. Sci.*, 1936, **5**, 390.

[2] *Mem. Dep. Agric. India Bot. Ser.*, 1928, **14**, 199–245.

Grafting of Apple on *Eriobotrya Japonica* Stocks

CONSIDERABLE attention has been devoted to apple root-stock problem in many Fruit Research Stations in Europe, and especially, in the East Malling Research Station in England. Various root-stocks such as the 'Northern Spy', 'Paradise' and others have been used for grafting apples. There has been very little work done in India, to find out a root-stock for apples suitable for the prevailing conditions. It is usual in this country to import from Australia, apple plants grafted on Northern Spy root-stock. From experience in the Mysore State, these plants have been found to be susceptible to root disease (Rhizoctonia) and deteriorate after a few years of bearing.

In the search for a hardy root-stock, a few buddings of apple were made during May 1936

FIG. 1

on *Eriobotrya Japonica*, which, though successful, did not make much headway.

Eriobotrya Japonica (Loquat) is a medium-sized tree belonging to the order *Rosaceæ*, introduced in India from Japan. It grows well in gardens and is able to resist drought conditions owing to its vigorous root-system.

Cleft grafts made with the 'Jonathan' and 'Rome Beauty' as scions, began to put forth shoots in 18 to 20 days. The accompanying photograph was taken when the graft was six weeks old. Though these grafts have shown promising signs of growth, the compatibility between the stock and scion can be ascertained only during the next season's growth. The further development of these grafts will be reported later.

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February 3, 1939.

A Terrestrial Species of Oedogonium

THIS is a preliminary note on a terrestrial species of *Oedogonium* collected by the author from Tanda and Fyzabad from August to October, 1938. So far no terrestrial species of Oedogonium has been described, and as compared with genus *Oedocladium*, some of whose species are terrestrial, *Oedogonium* is supposed to be a purely aquatic genus.

This species which appears in the form of green felt-like patches was found growing throughout the monsoon season in lawns, and compounds of houses. When the oospores ripen, the patches become orange-coloured. Ripe cospores are found in all the months, a few days of sunshine being enough to ripen the spores.

Vegetative cells are 6–8 μ broad and 26–70 μ long, are hyaline and unbranched with a rhizoidal function in the subterranean part, while the subaerial cells are 14–17 μ broad and 24–32 μ long. The alga is monoecious macrandrous. Oogonia are found singly, are globose, 30–42 μ in diameter and are operculate. Oospores are globose, do not fill the oogonia, have smooth chocolate-brown spore-wall and are 26–32 μ broad. Antheridia are 4–6 in number each containing one sperm, and are 11–14 μ broad and 6–10 μ long.

This is obviously a new species and has been named as *Oedogonium terrestris* sp. nov. The author is thankful to Dr. L. H. Tiffani of North Western University, Evanston, Illinois, U.S.A.,

for examining the material and communicating his views.

M. S. RANDHAWA.

Fyzabad,
January 14, 1939.

A Note on the Gametophyte of *Botrychium virginianum* var. *lanuginosum*, SW.

OUR knowledge of the prothalli, the germination and growth of spores of *Botrychium*, though scanty, is derived from the researches of Douglas Campbell[1] and Edward Jeffrey[2] who have described the American forms of the species *Botrychium virginianum*. The occurrence of this species of *B. virginianum* var. *lanuginosum* is reported from various places in India, but till now no account of its developmental history has been made known. The purpose of this note is to record a preliminary account of the gametophytes of the Indian variety *B. virginiaum* var. *lanuginosum*, which in certain respects differs from the published accounts.

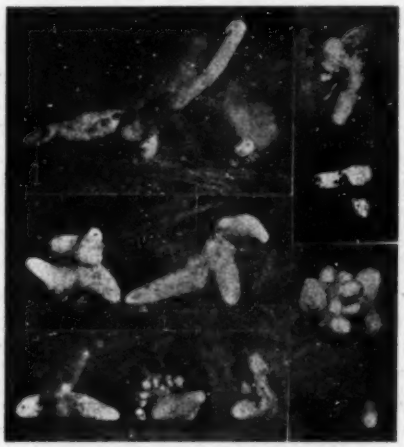

FIG. 1

Gametophytes of *Botrychium virginianum* var. *lanuginosum*, of different ages. Note the diversity of form and shape. At the left upper corner, the first leaf of a sporophyte with its circinate vernation can be seen. × 6.

In 1937, I obtained a large number of gametophytes of the variety *lanuginosum* from Kodaikanal and in the subsequent year, several younger stages were collected. The material which is under investigation has shown certain peculiarities well worth reporting at once. Campbell working on old prothalli has described them as flattened tubers, covered with root-hairs, with folded in margins and with reproductive organs buried on the superior surface. Regarding colouration, they were brown externally, though white in sections. Jeffrey working on fresh material has described the prothalli as flat and oval with root-hairs. According to him the growing point is at the narrow anterior end, the hinder part becoming thicker and wider. The antheridial ridge on the dorsal surface widens out in the older prothalli. The gametophytes of other species of *Botrychium* such as *B. lunaria*, *B. obliquum* and *B. simplex* have been described as being flat and dorsiventral bodies of varying shape, with an antheridial ridge on the superior surface. The prothalli of the Indian variety show essential differences. They are not flat

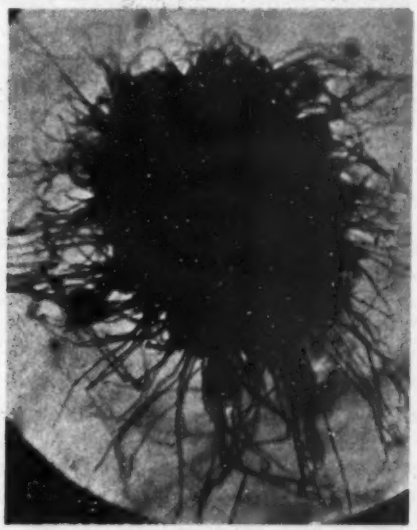

FIG. 2

Young prothallus with rhizoids. × 25.

dorsiventral bodies, but are spherical in shape, white in colour, having a number of irregular

indents on the otherwise smooth surface. They are generally smaller than the corresponding stages of the prothalli of the other species; and the subsequent growth of the former results in the assumption of a large variety of shapes shown in Fig. 2.

Endophytic fungus can be easily detected in bodies varying in size from 0·5 mm. to 0·2 mm. and if a young prothallus of this dimension is kept in a moist chamber, the fungus grows out in profusion. Separate cultures of the fungus have been prepared for studying the details of its life-history and association. The prothalli at the stage of the emergence of the endophytic fungus are devoid of rhizoids. The appearance of rhizoids synchronises with the change in colour of the prothalli from white to brown, and also marks the increase in their size (Fig. 1). When the colour changes into deep brown, the rhizoids are lost, fertilisation is completed, and on the young sporophyte developing, the prothalli increases in the size. Certain cases of prothalli almost entirely composed of sporophytic tissue have been noticed.

The results of further investigation will appear elsewhere.

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March 11, 1939.

Campbell. D. H., *Mosses and Ferns*, 1918.
—, *Ann. Bot.*, 1921, **35**, 141.
—, *Ibid.*, 1922, **36**, 441.
Jeffrey, E. C., *Trans. Canadian Institute*, 1898, **5**.

Eugenia jambolana

The bark, the seeds and the fruit pericarp of this plant have some reputation as cures for diabetes, chronic diarrhœa and dysentery and as gargle for sore-throat. Though a certain amount of work has been done regarding the chemical composition of the seeds, rather conflicting reports have been made. The earlier workers reported the presence of a glucoside (Börsch)[1], quercitol and cinnamic acid (Pottiez)[2] and that an extract of the kernels prevented diastatic hydrolysis of starch (Stephenson)[3]. Later workers (Power and Callan[4], Hart and Heyl[2]) were of the opinion that the seeds contained no alkaloid, glucoside or enzyme. Further some of the samples that were examined do not seem to have been preserved in good condition. The results of our examination of a fresh sample of the seeds obtained locally agree with those of Hart and Heyl except in regard to the presence of free sulphur which we could not detect. Ellagic and gallic acids together with tannins are probably responsible for the medicinal value of the seeds. We have also obtained small quantities of a sweet smelling yellowish green oil and a colourless crystalline solid which has the properties of a wax. It melts at 81–83° and the unsaponifiable part of it has been identified as myrical alcohol.

The fleshy pericarp of the fruits has not been examined before. It is now found that the sweetness of this material is entirely due to the presence of reducing sugars and that there is a total absence of sucrose. The sourness and astringency seem to be due to the presence of gallic acid and tannin. A fairly high percentage (0·6% of the weight of the dried pericarp) of ammonium chloride could be isolated. The beautiful purple colour is partly due to the occurrence of an anthocyanin, which has been identified as cyanin. During our attempts to isolate this pigment, it was realised that a considerable portion of the colour is due to the presence of a second pigment, which is phenolic in nature and crystallises from dilute alcohol as snuff-coloured plates melting above 300° C.

Two colourless crystalline compounds have also been isolated from the pericarp, one melting at 149° C. and the other at 232° C. The first is easily soluble in alcohol and gives a bluish violet fluorescence when dissolved either in aqueous sodium carbonate or sodium hydroxide or in concentrated sulphuric acid. It seems to belong to the group of hydroxybenzopyrones. The second is far less soluble in alcohol and gives a pale green fluorescence

in concentrated sulphuric acid. Detailed reports about these compounds will soon be published.

N. V. SUBBA RAO.
T. R. SESHADRI.

Department of Chemical Technology,
Andhra University, Waltair,
February 22, 1939.

[1] Börsch, *Pharm. Zig.*, 1899, **44**, 574.
[2] Hart and Heyl, *J.A.C.S.*, 1916, p. 2805.
[3] Pottier, *Ann. Pharm. Louvian*, 1899, **5**, 373, 490.
[4] Power and Callan, *Pharm. J.*, 1912, **34**, 414; 1913, **91**, 245; *J.C.S.*, Abst., 1912, ii, 480: 1913, i, 1057
[5] Stephenson, *Pharm. J.P.*, 1892, 211.

Effect of Colchicine on Plant Cells

RECENT discovery by Blakeslee and Avery[1] that dilute concentrations of colchicine can induce polyploidy in the plant cells is considered by many to be an important advance in plant genetics. This line of investigation is being pursued extensively not only with colchicine but with other chemicals also.[2,3] Experiments conducted in this laboratory to study the manner of action of the alkaloid colchicine have given results of interest. The method used was to study paraffin sections of root tip material, which had been treated with the drug. The growing root tips of *Pinus excelsa*, *Lathyrus odoratus* and *Allium cepa* were used, and the material was fixed soon after treatment, so that the dividing cells showed the effect of the drug. The fixative used was a chromic-osmic-acetic combination, which gave perfectly reliable results with these and other plant materials. The summary of results is as follows:—

1. The sprouted seeds of *Pinus excelsa* and *Pinus gerardiana* were so arranged that the radicle grew into a 1 in 1000 aqueous solution of colchicine. All the root tips survived and grew well, and the cells were invariably affected after 24 hours treatment. The typical effect of colchicine, irregular arrangement of chromosomes, failure of anaphase stage, and production of tetraploid cells were observed. A feature of interest was the striking elongation of all the dividing cells as a result of which the radicle lengthens during treatment. The microphotographs A and B are of cells from treated and untreated root tips of *Pinus gerardiana*. Both were taken at the same magnification ($90 \times 10 \times$ F. for Bellows extension). Photograph A is from untreated root tips and two dividing cells are shown. B is taken from treated root tips and the arrangement of chromosomes in the single central cells shows the extreme elongation of the cell. From this it is to be inferred that colchicine affects not only the spindle mechanism, but also the whole cell.

Fig. A
Dividing cells from untreated root tip of *Pinus*

Fig. B
Dividing cells from treated root tip of *Pinus*

2. With *Allium*, bulbs were used, and practical difficulties had to be overcome before good growth could be obtained in aqueous colchicine. The 1 in 1000 solution gave results after 24 hours treatment. The characteristic results, namely, the irregular metaphase plate, and the failure of anaphase during division, were obtained. A feature of interest was, the chromosome structure was affected along with the chromosome behaviour. The spiral structure of telophase chromosomes twisting between sister chromatids during prophase, and the manner of chromatid separation at metaphase were more clear in treated material than in control root tips. Microphotograph C is that of an elongated nucleus probably in the

telophase stage. A few evidences of spiral structure in the chromosome is visible even in the photograph. From similar observations it is inferred that colchicine may prove a valuable tool in studying chromosome structure. Koshy's[4] and other recent publications show that there are important problems in chromosome behaviour which can be solved by accurate study of chromosome structure and in those problems the new tool will be of help.

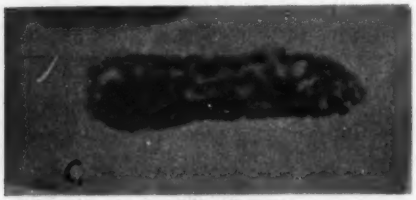

Fig. C

Nucleus from treated root tip of *Allium cepa*

3. Sprouted *Lathyrus* seeds were arranged to let the radicle grow into aqueous colchicine. Three strengths were used, 1 in 500, 1 in 1000, and 1 in 2000. At extreme dilution no cytological peculiarities were observed. At the other two dilutions results were obtained, which can be interpreted as a disintegration of dividing nuclei brought about by the drug. The reasons for such an interpretation are: (*a*) the cells concerned were not in the resting stage for they were totally unlike the normally fixed resting nuclei, (*b*) the appearance could not have been due to faulty technique, for root tips of *Rheo discolor* which were fixed and imbedded along with the treated material showed normal division, (*c*) there were deep staining spiral fragments within the nuclear membrane. The disintegrative action of colchicine on the nucleus suggests that in less harmful doses the drug may increase the mutation rate of *Lathyrus*. Such a possibility is being investigated.

Another feature of interest was noticed when respiration rate was studied in treated material. Sprouted seeds were soaked for 6 and 18 hours in 1 in 1000 aqueous solution of colchicine. The rate was 0·311 mgm. and 0·204 mgm. of CO_2 per hour per gram fresh weight, after 6 and 18 hours respectively. A control batch of seeds kept under similar conditions, gave the readings 0·103 and 0·293 after 6 and 18 hours interval respectively. Possibly the result may be due to an initial stimulation followed by a retardation. The possible connection between the naturally occurring alkaloid in a few dicotyledonous species and the response of those species to colchicine is being investigated.

S. Sampath.
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R. K. Bansal.

Institute of Agricultural Research,
Benares Hindu University,
November 12, 1938.

[1] Blakeslee and Avery, *Jour. Heredity*, 1937, **28**, 393.
[2] Dontcho Kostoff, *Curr. Sci.*, 1938, **7**, 108.
[3] Nebel and Ruttle, *Jour. Heredity*, 1938, **29**, 3.
[4] Koshy, *Jour. Roy. Micros. Soc.*, 1933, **53**, 299.

Koleroga Disease of Areca Nut

In North Kanara, Bombay Province, *Phytophthora arecæ* (Coleman) Pethybridge has not as yet been found occurring on any plant other than areca nut, nor have the oospores of the fungus been discovered under natural conditions. It is, therefore, difficult to explain the carry-over of the disease from one year to the next. However, in infected gardens one usually meets with diseased tree-tops, the infection of which takes place either from the affected bunch or through the leaf-sheaths which form the protective covering to the growing-point of the tree. Sometime ago it was suggested by one of us that the fungus, probably hibernates, as dormant mycelium in the dying tree-tops and, on the return of favourable conditions in late May or early June, it resumes vegetative activity and produces numerous sporangia which are disseminated by wind and initiate centres of infection in the same or neighbouring gardens from which the disease may be spread rapidly during the monsoon.

Beginning with October, isolations were made at intervals of one month by planting bits of diseased tops cut out aseptically on plates of Quaker-oats agar. The fungus was readily brought into pure culture, but later in the dry season it was found mixed with saprophytic

bacteria which invade infected tops. The pathogenicity of the isolates was tested on young areca nuts. It was also noticed that, as the dry season advanced, the number of successful isolations was somewhat less than in the months immediately following the wet season. The position, however, seems to change as the weather becomes cool and moist before the onset of the monsoon. The fungus now wakes to activity from its dormant state and resumes vegetative growth. Fig. 1 is a photograph of an infected tree-top taken on May 25, 1938, showing profuse vegetative growth when

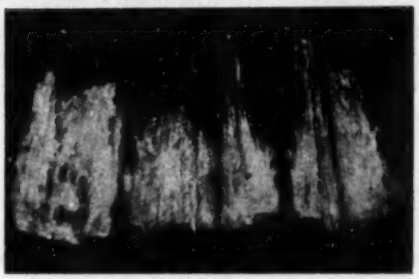

FIG. 1

the top was split open; young nuts were readily infected with material taken direct from the diseased top. However, under favourable conditions it is not uncommon to encounter dying tree-tops early in the dry season, in which cavities develop in the pith, usually containing a more or less dense growth of the mycelium of the fungus. Fig. 2 is a photograph of an infected top taken on February 4, 1939, showing vigorous growth of mycelium in the cavities of the pith.

FIG. 2

In 1930, Narasimhan[1] reported the occurrence of heterothallic strains of *P. arecæ*. He showed, for example, that when single-spore cultures of the Areca and Santalum strains are grown together on Quaker-oats agar medium in Petri dishes, oospores are formed at the junction of the two mycelia. He further showed that the Areca strain possesses male characteristics as its mycelium bears antheridia and that the Santalum strain is female. He thus came to the conclusion that the absence of oospores in *P. arecæ* may be explained on the basis of the two sexual strains having been isolated on different host plants in nature.

Evidence has been obtained that heterothallic strains of *P. arecæ* may occur on areca nut in nature. Isolations of the fungus were made from diseased nuts in different localities in North Kanara and grown in different combinations on Quaker-oats agar medium in Petri dishes. The results of one of the experiments given in Table I show that the Tyagli and

TABLE I

Results obtained by pairing strains of P. arecæ *isolated from areca nut growing in different localities*

Strains paired	Oospore formation
Hipnalli × Vargheshwar	–
Hipnalli × Dambheshwar	–
Honavar × Dambheshwar	–
Nilekani × Harogar	–
Tyagli × Hipnalli	+
Tyagli × Vargheshwar	+
Tyagli × Dambheshwar	+
Tyagli × Honavar	+
Tyagli × Nilekani	+
Tyagli × Harogar	+
Analgar × Hipnalli	+
Analgar × Nilekani	+
Tyagli × Analgar	–

N.B.—The strains take their names after the villages in which they occur.

Analgar strains possess similar sexual potentiality and always produce oospores when

paired with any one of the other six strains. It appears that the sexual strains of the fungus have become definitely isolated in different areas, and this localisation of the two sex strains may explain the absence of oospore formation in nature. The case reported by Narasimhan[1] when Coleman once obtained oospores in areca nuts placed in Roux tubes and inoculated with a culture of *P. arecæ*, can now be satisfactorily explained by assuming that the nuts were carrying natural infection with one of the strains occurring on areca nut trees and that the culture used for inoculation must have been of the opposite sex.

B. N. Uppal.
M. K. Desai.

College of Agriculture,
Poona,
February 21, 1939.

[1] Narasimhan, M. J., *Phytopath.*, 1930, 20, 201–14.

A Re-description of *Lemdana marthae* Seurat, 1917

Lemdana marthæ, the only species of its genus was described by Seurat in 1917. This nematode has so far not been recorded from India. The figures given by Seurat do not show the specific characters. The description

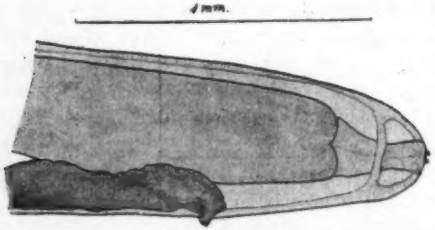

Fig. 1

Lemdana marthæ. Anterior end of female, lateral view showing the vulva

also is hazy, hence it is considered to redescribe this nematode.

Five females and two males of *Lemdana marthæ* were found under the epithelium in the neck region of a Spotted Babbler—*Pellorneum ruficeps*.

The females measure 32·9 mm. × 0·63 mm. to 45·3 mm. × 0·7 mm. The mouth is simple without lips. There is a pair of head-papillæ and a pair of amphids present. The nerve-ring is found just behind the anterior end.

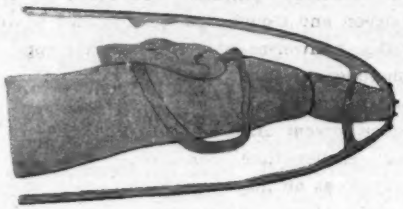

Fig. 2

Lemdana marthæ. Anterior end of male, dorsal view showing the head-papillæ and amphids

Cuticle is thick and smooth. The œsophagus is divided into two parts—an anterior short clear muscular portion measuring 0·36 mm., and a large dark glandular portion measuring

Fig. 3

Lemdana marthæ. Posterior end of male showing the position of papillæ

9·22 mm. in a female 32·9 mm. long. The vulva is very prominent and lies at a distance of 0·74 mm. from the anterior end. The anus lies near the conical posterior end and bears three subventral papillæ.

The males measure 18·9 mm. × 0·46 mm. Caudal alæ are absent. There are four pairs of pre-anal and a single pair of post-anal papillæ. The spicules are very unequal. The right spicule measures 0·32 mm. and the left spicule is 2·15 mm. in length.

The microfilaræ are unsheathed and found in the blood.

Host—Pellorneum ruficeps.

Location—Neck region.

Distribution—Aligarh, U.P., India.

M. B. Mirza.

Department of Zoology,
Muslim University, Aligarh, U.P.,
March 7, 1939.

[1] Sprehn, *Lehrbuch der Helminthology*, Berlin, 1932.
[2] York and Maplestone, *The Nematode Parasites of Vertebrates*, London, 1926.

Identity of Two Important Parasites hitherto considered as Distinct Species

THE Braconid parasite, *Microbracon lefroyi* Dudgeon and Gough, has been known to attack spotted bollworms of cotton (*Earias* spp.) and sometimes also the pink bollworm, *Platyedra gossypiella* Saund. Another Braconid, *Microbracon greeni* Ashmead, though known from much earlier time, has recently assumed importance as an important parasite of *Eublemma amabilis* Moore and *Holcocera pulverea* Meyr., which, being serious enemies of the lac insect, reduce the production of lac. The two parasites, *M. lefroyi* and *M. greeni* are very similar to each other in general appearance and morphology so much so that it is often impossible to separate them on structural grounds. Ramakrishna Ayyar (1928) also suspected them to be identical but at the time he did not go further than indicate their very close relationship.

The correct identification of these parasites, however, is a matter of great importance. They attack hosts which are economically very important and give considerable promise of being used in biological control work. It became, therefore, necessary to discover the specific distinctions, if any, between these two parasites. With this end in view, a large series of specimens of *M. lefroyi* available in the Pusa collection (identified by Brues) and also bred in the laboratory of the Imperial Entomologist and of *M. greeni* reared at the Lac Research Institute, Namkum, and made available through the courtesy of the Entomologist of that Institute, was examined.

It is a well-known fact that there are enormous variations within many of the species of the genus *Microbracon*. Perhaps the two most variable characters are size and colouration so much so that they often are practically useless by themselves in any specific determination. This is specially the case with the species *lefroyi* and *greeni*. Brues (1919), therefore, in his redescription of *lefroyi* recognised "melanic" and "light" forms: in the former black markings, though variable, included spot on front above base of antennæ, ocellar space, occiput, antennæ, stripe on each of the three lobes of mesonotum, scutellum, propodeum, irregular marks on pleuræ, abdominal segments 3-5 except narrow lateral border and sheaths of ovipositor. The 'light' forms were pale honey yellow with only the flagellum of antennæ, tips of mandibles, ocellar triangle, clouds on third and fourth abdominal segments and ovipositor black, piceous or brown. Ashmead's (1896) original description of *greeni* refers to the disc of metathorax, extreme apex of second abdominal segment and large dorsal blotches on third and fourth segments black. But breeding work on *lefroyi* under different conditions of temperature and humidity carried out by my colleague, Dr. Tashkir Ahmad has shown that these colour characters are not only most variable but that they can almost be produced at will by altering the temperature under which the parasites are reared. Thus under temperature of 16° C. only very dark forms emerge, while higher temperatures bring about greater lightness of body colouration. In size, specimens of both vary widely between 2 and 3·5 mm.

Differentiation between *lefroyi* and *greeni* on the so-called specific structural characters also breaks down when a long series of specimens of both is examined. Both have the antennæ 24-27 jointed, the ocelli in a triangle and the ocellar area dark, though this darkness is often, though not always, absent in *greeni*. The second abscissa of radius in the forewing of both varies from 1½ to over 3 times the first: in the figure of the wing of *lefroyi* given by Dudgeon and Gough (1913), it is easily 3 times and in Ashmead's description of *greeni* it is also said to be 3 times. The abdomen in both is roundish or broadly oval and the proportion of the lengths of the respective segments same. The length of ovipositor in both is again variable. In Ashmead's description it is 2/3 the length of abdomen but in a large number of specimens examined by me it is easily half the body length, a proportion which was originally given for the ovipositor of *lefroyi* by Dudgeon and Gough. It is clear that there is

not a single constant morphological character by which *lefroyi* and *greeni* can be distinguished, and they should, therefore, be regarded as identical.

Though morphologically indistinguishable the two parasites, however, do not, as a rule, oviposit on the same hosts. Attempts to induce *greeni* to oviposit on *Earias* spp., under different temperature conditions, have invariably failed at New Delhi. The larvæ were not even paralysed. The two parasites also seem to have some other biological differences, for example, those relating to the conditions for oviposition. It is evident, therefore, that *M. lefroyi* and *M. greeni* are two biological races of the same species. Since *greeni* was described earlier than *lefroyi*, the correct name of the parasites should be *Microbracon greeni* (Ashmead) race *lefroyi* and *M. greeni* (Ashmead) race *greeni*.

I wish to thank Dr. Hem Singh Pruthi, Imperial Entomologist, for kindly allowing me to make use of the observations of his other staff and for reading through the manuscript of this note.

K. B. Lal.

Imperial Agricultural Research Institute,
New Delhi,
March 7, 1939.

[1] Ashmead, Wm. H., *Proc. U.S. Nat. Mus.*, 1896, **18**, 633.
[2] Brues, C. T., *Rept. Proc. 3rd Ent. Meeting*, Pusa, 1920, **3**, 1026.
[3] Dudgeon, G. C., and Gough, L. H., *Agric. Jour. Egypt*, 1913, **3**, 108.
[4] Ramakrishna Ayyar, T. V., *Mem. Dept. Agric. India, Ent. Ser.*, 1928, **10**, 29.

Research Work on the Hilsa

The review[1] of Dr. Hora's recent paper on Hilsa* by Mr. J. Travis Jenkins has, we fear, hardly done justice to the research on the same fish carried on in the province of Madras. To the reader not acquainted with the investigations, the review is likely to convey the impression that they are confined to the province of Bengal. The following extracts from the review, for instance, are open to challenge:—

(1) "Until the recent discoveries of Dr. Hora which are described in the paper under review, practically nothing definite was known of the spawning habits and grounds of the Hilsa, though there was naturally much guess-work."

(2) "In spite of investigations made by several scientists, no step forward was made until Dr. Hora discovered large numbers of very small Hilsa, etc."

(3) "Now that the first and most difficult step has been taken by Dr. Hora in elucidating the mystery of the spawning of the Hilsa, we await further discoveries in the near future, and in particular, the eggs and first larval stages."

Mr. H. C. Wilson succeeded in hatching Hilsa eggs as early as 1908 and 1909 and Dr. B. Sundara Raj succeeded in hatching out ten million fry at the Coleroon hatchery in 1916. The collection and hatching of Hilsa eggs continues as a routine at Madras.

Quite different is the impression one gets by a perusal of the paper by Dr. S. L. Hora; for this author has faithfully summarised the work relating to Hilsa done in this province. By omitting the share of work done by the Department of Fisheries, Madras, from the scope of his otherwise complete review, Mr. Jenkins has, we fear, run the risk of misleading the average reader unfamiliar with the work on this anodromous or estuarine fish.

D. W. Devanesen.

Marine Biological Station,
Krusadai Island,
Gulf of Mannar.
January 17, 1939.

[1] *Vide* pp. 251 and 252 of *Current Science*, No. 5, Nov. 1938.

* "A Preliminary Note on the Spawning Grounds and Bionomics of the so-called Indian Shad, *Hilsa ilisha* (Hamilton) in the River Ganges," by Sunder Lal Hora, *Records of the Indian Museum*, 1938, **40**, Pt. II, 147–58.

REVIEWS

Lectures on Quantum Mechanics, Vol. I. By M. R. Siddiqi, Professor of Mathematics, Osmania University. (Osmania University Publications), 1938. Rs. 6 or 8*s*. 6*d*. net.

This is the first Indian publication of a text-book on Quantum Mechanics, and can certainly take its place among the best of the elementary books written on the subject. The author intends to deal with the advanced portions in a second volume, and we hope that this will be published early so that the two volumes might go a long way in popularising the study of this most important subject in our Universities. We had had too much of Statics and Dynamics, Attractions and Potential, Spherical Astronomy, Theory of Elasticity, Celestial Mechanics, Classical Electricity and Magnetism and subjects of a similar nature in the curricula of special subjects for the Honours and Master's degree examinations of our Universities, and it is time that we taught something more modern in outlook, offering wider possibilities for investigation and research. The book under review written on a subject of this type by one who has made a thorough study of the subject, and is conversant with Indian standards will prove very useful for this purpose.

The book consists of eleven chapters of which the first four are of an introductory nature dealing with special relativity, classical mechanics and physical notions of atomic structure and reaction theory. The author has made a departure from the usual practice in presenting relativity theory before dealing with the general Hamiltonian theory of classical dynamics. This is certainly simpler since it makes it easier to introduce naturally the notions of the relativistic Lagrangian and Hamiltonian. In fact, the author has taken advantage of the notorious difficulty, not yet overcome, of the introduction of the methods of transformation theory into classical relativity. A welcome feature of the chapter on the structure of the atom is the mention of the discovery of the positron and neutron, and the great simplification introduced in nuclear physics by Heisenberg's conception of the structure of nucleii as made up of only protons and neutrons. The fifth chapter is devoted to Bohr's transitional theory, the sixth to Heisenberg's matrix mechanics, and the seventh and eighth to Schrödinger's wave mechanics. The perturbation theory which is most important in all applications of quantum mechanics is given in the ninth chapter from both the wave and matrix points of view. The tenth chapter is philosophical in outlook, and contains an excellent critique of the concepts of indeterminacy and causality. The last chapter contains Dirac's theory of the electron, and in view of the fact that there is really nothing inherently difficult in this theory, the author has wisely decided to include it in the first volume of the work.

We might notice some special features of the book. The development of matrix analysis, the explanation of the notions of eigen-values and eigen-functions, and the proof of the equivalence of the wave and matrix methods are all extremely well done. The essentials of the theory of the neutral helium atom are presented in a simple and lucid manner. The deduction of the uncertainty relation as a consequence of the quantum condition is presented at great length unlike many other elementary books.

The great difficulty in writing a book on quantum mechanics is the question of choice of material. The applications are so important and so numerous that in trying to present as many of these as possible, one has to sacrifice the logical development of the fundamental notions. Dr. Siddiqi has carefully kept this in mind when writing the book, and the result is an eminently readable, well reasoned out and nicely balanced text-book.

The printing and get-up are excellent, and the book is moderately priced.

B. S. Madhava Rao.

Grimsehl's Lehrbuch der Physik. Vol. II, Part I. The Electro-magnetic Field and Optics. Rewritten and enlarged by Professor Dr. R. Tomaschek, (B. G. Teubner, Berlin and Leipzig), 1938. Pp. 866. Price R.M. 26.

The book is divided into four sections: I. Static, Electric and Magnetic Fields. II. Direct Current Electricity. III. Periodically Varying Electro-magnetic Fields. IV. Optics. To electricity and magnetism 575 pages are devoted, and to light 262 pages. An appendix of useful physical and mathematical tables is included with the book.

This text is intended for students who have had a good introductory course in general physics and for the use of instructors in higher schools and colleges. The standard is hardly equal to that of the Indian University B.Sc. requirements though the scope is very much greater.

Since the value of a teacher is to be measured, in part at least, by his ability to present his subject as a living growing unified whole, related to the world in which we live, the alert and progressive teacher of physics will welcome such aids as Grimsehl's *Lehrbuch der Physik*. A very valuable feature of the book is the correlation between physical theory and practice, in modern society. This is an aspect of physics teaching in India which deserves attention.

The enormous number of topics discussed in the 837 pages of text necessitates great economy of words. The exposition, though brief, is clear. The 1,209 excellent diagrams and photographic illustrations greatly enhance the value of the work. Mathematics is used rather sparingly.

A considerable number of important recent technical developments are described, among these being the new high efficiency vapour-arc-fluorescence lamps, electron tube circuit breakers, magnetic and electric lenses for focussing electron beams and the ultra electron-microscope, the cyclotron, etc. The strong technical bias of the book will inspire the reader with a sense of the reality of physics and of its immediate value in every-day life. Such a book helps one to realize what science does, and what it might, contribute to human welfare, not only in material things but even more in the cultural realm.

Probably the chief value of Grimsehl's text in India will be in providing the teacher of college physics with inspiration and ideas for lecture demonstrations. Those who have to do with the framing of university physics courses, and compilers of physics text-books, will do well to carefully consider the material and treatment in this book.

Unfortunately, because of the language difficulty, the book under discussion is available to only a small number of those who need it. It is to be lamented that because of language barriers, much of the world's cultural wealth is accessible to limited groups of people only. How much better it would be if we could learn to co-operate in the matter of language and in every field of human activity rather than continue the strife to cultivate and maintain racial and national prejudices and thus perpetuate needless handicaps.

J. M. BENADE.

A Manual of Radioactivity. By Hevesy and Paneth. II Edition. (Oxford University Press, London), 1938. Pp. 306. Price 17*s*. 6*d*.

A few years ago 'Radioactivity' was a fairly well-defined subject; but it is becoming increasingly difficult to prescribe its boundaries, for the immense field of nuclear physics has grown out of it. 'The Child is the father of the Man' in more senses than one, and this precocious infant, Nuclear Physics, has lost no time in adopting its parent. The spontaneous disintegration of atoms is now looked upon as one nuclear phenomenon amongst many others, to be explained in terms of our general understanding of nuclear structure, and not as a mysterious anomaly in the scheme of Nature.

In this second edition of a well-known text-book of radioactivity the authors have thought fit, as far as possible, to keep within the old limits. This is a wise choice, for otherwise the whole character of the book would have been changed. But to keep entirely within the old limits would scarcely have been possible, still less desirable. In 1926, when the first English edition was published, the nucleus was unknown territory, though speculation was working on such experimental facts as were available. In that edition, the chapter on 'The Structure of the Atomic Nucleus' now reads like

a page from some ancient history, though it was orthodox science at the time. Such a remark as "We can state with certainty that in the uranium nucleus, for example, there must be at least 6 electrons, corresponding to the 6 β-raying daughter elements" now sounds very naive; but it is well, in our superior wisdom, not to forget that the orthodoxy of to-day may be equally naive to-morrow.

Nevertheless, the genuine progress that has been made, in the twelve years intervening between these two editions, is surely very remarkable. The nucleus may still be unknown territory, but it can be broken up by bombardment from without, and forced to yield some of its secrets. It is fitting that an account of this should now find a place in three compact but very useful chapters. Otherwise the chapter headings are generally similar to those of the first edition, though the contents of the chapters have been brought up to date, and modern developments have received due attention.

The general design of the book remains unchanged. It is intended primarily to be a book for the student, and the arrangement of material largely ignores the historical order of discovery. A short historical survey forms the last chapter. Also quite deliberately, no attempt is made to provide a bibliography, but at the end of the chapters a few references are given to other books and to representative original papers. Naturally, much detail is omitted, for an attempt to be exhaustive would again defeat the purpose of the authors in providing a text-book suitable for students. All who have used the book in its first edition are aware that within these chosen limits it forms an admirable survey of the field of radioactivity, and in the second edition the high standard has been well maintained. We must, therefore, welcome the new edition as a timely and valuable contribution to the literature of the subject.

Although the book is intended primarily for the student, there are few workers in radioactivity so omniscient that they will not learn something from it. One of the valuable features is the large number of tables, which in many cases, give numerical results so fully as to make the book a useful work of reference. Many numerical data are given on quite modern work, such as artificial radioactivity, which the average student may not readily find elsewhere, and which the research worker may be quite glad to find gathered together in convenient form. The graphs, diagrams, and other illustrations, are extremely clear.

Another useful feature is the careful detail in which information is gathered together on topics which are not always referred to in other works. The chapters dealing with the preparation and chemistry of the radioactive elements, and the chemical behaviour of substances present in extremely small amounts, are examples of this. A discussion is given of various effects produced by the rays from radioactive substances, including biological effects. There is also an important chapter on the connection with geology and the radioactive methods of determining the age of the rocks.

The translation is well done, though here and there a reader familiar with German will catch a reminiscence of the original. Errors of fact, or of printing, are extremely rare; the reviewer has noticed only one or two very minor points of this kind. It need hardly be said that the paper, printing and binding are all of the high standard which we expect from the Oxford University Press.

This book is, on all accounts, very suitable for those who wish to gain an insight into the domain of radioactivity, and is to be warmly commended.

H. J. TAYLOR.

Stream and Channel Flow. By E. E. Morgan. (Chapman & Hall, Ltd., London), 1938. Pp. 240. Price 25*s*.

This is essentially a book of Hydraulic Graphs and Tables for the everyday use of engineers. The author himself writes in the Preface that "Calculations relating to the uniform flow of water in open channels and streams being laborious, the author prepared for his own use a set of graphs and tables, by means of which velocity and discharge problems could be solved in a quick and simple manner. These have also been used by the River Branch of the Highways and Bridges Department of the Surrey County Council and their success

has encouraged the author to publish them for the assistance of others engaged on work of a similar nature."

The author has used Manning's formula

$$V = M R^{2/3} S^{1/2}$$

where M, the coefficient of roughness has been given a definite value or has been expressed as $1{\cdot}4858/n$ where n another form of the coefficient of roughness has the same values as in Ganguillet and Kutter's formula.

The author says that the selection of Manning's formula was the result of a very careful investigation by the author and "recent research on this subject" he says, "has confirmed rather than otherwise the choice of this formula for channel flow".

There is a chapter on "Recent Researches" dealing with the experiment of Nikurdse and Prandtl-von Karman formula for rough and smooth pipes. The author shows that if the substitution of the hydraulic mean depth in place of the diameter is correct then the author's use of Manning's formula for rectangular concrete closed culvert is confirmed by the Prandtl-von Karman formula for rough pipes.

So far the author is on sure grounds but when he turns to the application of Manning's formula to natural streams and canals he is forced to admit that "Although the indirect application of the von Karman-Prandtl formula for rough pipes to rivers, streams and canals appears to confirm the use of Manning's formula by the author, yet, in the case of natural streams at least, the direct application of the equation

$$v = 4\sqrt{2g}\left(\log \frac{R}{\epsilon} + 1{\cdot}17\right)\sqrt{RS},$$

is dependent upon entirely fictitious assumptions."

In spite of this fact and of the fact that "the choice of the appropriate value of n to suit the conditions of the channel is largely a matter of judgment" the author has found from his own experience that the application of Manning's formula to earthen channels and rivers gives a better agreement than any other existing formula. Of the existing formula for open flow he mentions those of Chezy, Kutter and Bazin. No mention is made of the fomulæ of Kennedy or Lacey though in India these are mostly used.

In the Tables themselves there is a departure from the usual practice. The author gives a table for $\sqrt{S}$ for different values of the slope and then splits up the expression for velocity and discharge so that

$$V = \left[\frac{1{\cdot}4858}{n} R^{2/3}\right] \cdot S^{1/2}$$

$$Q = \left[A \frac{1{\cdot}4858}{n} R^{2/3}\right] \cdot S^{1/2}$$

and denotes

$$\left[\frac{1{\cdot}4858}{n} R^{2/3}\right]$$ as the Velocity Multiplier and

$$\left[A \frac{1{\cdot}4858}{n} R^{2/3}\right]$$ as the Discharge Multiplier.

Tables are also supplied for these "Multipliers" for the three values of n.

$n = 0{\cdot}025$
$n = 0{\cdot}030$
$n = 0{\cdot}014$

N. K. B.

The Phase Rule and Phase Reactions—Theoretical and Practical. By Sydney T. Bowden. (Macmillan & Co., London), 1938. Pp. 302. Price 10*s.* net.

Phase rule, in comparison with other branches of physico-chemical knowledge, has attracted fewer workers and exponents. Neither the number of books on Phase rule nor the space usually allotted to its treatment in text-books is commensurate with the importance of the subject. The appearance of a new book on the subject, like the one by Dr. S. T. Bowden is, therefore, to be warmly welcomed.

The book "is intended to serve both as a theoretical and practical text-book and covers the requirements of the Higher School Certificate and the degree examination of the Universities". A perusal of the contents of the book convinces one that this is a very modest description of the scope of the book. Every branch of the subject has received adequate attention and every principle has been amply illustrated by numerous examples, special attention having been paid to the practical aspects. A special feature of the book is that 'a number of typical experiments are described in detail'. Every teacher of

Chemistry will endorse the view of the author: "The fact that a student has no time to perform a particular experiment need not preclude him from knowing how it is done". It is in fact these descriptions that have contributed to make this book specially useful to the student and the teacher. Typical questions have been included at the close of each chapter and this enhances the usefulness of the book.

Dr. Bowden has written his book in easy and beautiful style and most of the chapters and several sections are decked with choice and pithy quotations from poetical and scientific writings—a feature that Mellor made familiar. This book should find a high place in didactic chemical literature.

A. N. K.

Research and Statistical Methodology Books and Reviews. Edited by Oscar Krisen Buros. (Rutgers University Press), 1938. Pp. vi + 100. Price $1·25.

This publication is a reprint of the bibliography and book-review section of "The 1938 Mental Measurements Yearbook of the School of Education of Rutgers University", and contains a fairly exhaustive list of important monographs, books of tables and statistical methodology dealing with the modern developments in statistical technique as applied to a comprehensive list of subjects like biology, agronomy, education, psychology, actuarial mathematics, business, economics, engineering, forestry, sociology and vital statistics. The title of each monograph and book is followed by full bibliographic references, along with references of important reviews in the English language.

The publication of this volume supplies a long-felt want; and we believe that the author has, by undertaking the labour of examining critically hundreds of statistical journals and books, rendered a distinct service to research workers in statistics. The proposal to issue this publication every year deserves full support. The value of the book will be further enhanced if, space permitting, a list of important papers and memoirs of the year on various branches of statistics appearing in the leading statistical journals can also be included.

K. KISHEN.

Balance of Payment, 1937. (League of Nations, Geneva), 1938. Pp. 212. Price 6*s*.

This issue analyses the international payments of almost all the chief commercial countries of the world in recent years. To facilitate analysis and interpretation of statistics relating to international balance of payments, most of the statements for individual countries are compiled on the basis of standard forms. Comparable figures are given in the case of practically all the countries represented for goods, interest and dividends, other services, gold and long-terms and short-terms capital movements.

Most of the detailed statements in the case of individual countries are accompanied by a summary table of balances of payments, together with the totals of all inward and outward payments for the last few years. To facilitate international comparison, these balances have also been combined in a table where they are converted into United States gold dollars at the old parity.

An interesting chapter is devoted to a detailed analysis of recent trends in commercial transactions. It contains an exhaustive study of the changes in connection with current items in the trade of creditor and debtor countries, and international capital movements from one country to another. It will be seen that since 1931 the debtor countries have had a large active balance in the case of these items (*i.e.*, transactions in goods and services, *plus* newly-produced gold exported), aggregating for the period 1931–37 to some 5 milliards of dollars (at the old gold parity of the dollar), which has thus been available for reduction of their foreign debt. In addition, some debtor countries have employed funds derived from the sale of foreign holdings or gold reserves in banks for debt reduction. On the other hand, certain debtor countries, particularly those within the sterling block, have built up large foreign exchange reserves in London and New York. It will also be seen that creditor countries in recent years have drawn upon their foreign assets to a greater extent than has been commonly supposed.

A special section is devoted to the speculative movements of capital between creditor countries. The inflow of capital to the United States is analysed by means of diagrams showing, *e.g.*, the relation between the amount of foreign purchases of securities

on the one hand and share prices on the New York Stock Exchange on the other, and again between the inflow of foreign bank funds on the one hand and the total amounts lent to brokers and Stock Exchange operators on the other. The effects of tourist traffic, emigrants' remittances, the capital market and gold movements are also analysed.

The above brief particulars will show the interest attaching to the 1937 issue of *Balances of Payments* for the purposes of economists and business men.

TARINIPROSAD GHOSE.

International Trade Statistics, 1937. (League of Nations, Geneva), 1938. Pp. 450. Price 12*s.* 6*d.*

This volume published by the Economic Intelligence Service of the League of Nations contains very useful information of foreign trade statistics of 66 countries (instead of 65 as in former editions) for the years 1935–37. Statistics of imports and exports of goods per year and per month, the imports and exports per country and the imports and exports per principal articles, the imports and exports of bullion and specie, all these have been presented in tabular forms in a very lucid manner.

One marked feature of the 1937 edition of the *International Trade Statistics* is the grouping of imports and exports according to the international classification drawn up by the League of Nations Committee of Statistical Experts. The advantage of this new classification is that it enables international comparisons to be made on a scientific basis, not only for raw materials but also for various types of finished products.

This is a most useful volume and contains all but about 5 p.c. of the entire foreign trade statistics of the world.

TARINIPROSAD GHOSE.

Chronic Diseases of the Abdomen—A Diagnostic System. By C. Jennings Marshall. (Chapman & Hall, Ltd., London), 1938. Pp. 247. Price 25*sh.* net.

This is a book which must commend itself to all those who have to deal with conditions in the abdomen, both acute and chronic and as such it is equally interesting to the Surgeon, Gynæcologist and the Physician. It is of special value to the student who is preparing for higher examinations, as a great deal of information is available, both clinical and theoretical, in the different diagnosis of an abdominal case. The reading is somewhat terse but the tabular statements and the cross references give ample opportunities of understanding the subject to the student.

The illustrations are of great value and the radiographs are typical and clear.

The volume consists of 2 parts, the first dealing with the casting of the 'diagnostic net' and the investigations that could be carried out in any case where the main features are fixed on a particular system; the second part deals with abdominal pain, dealt with region by region, with the important conditions which may give rise to it in a classified manner. Lastly, the series of sections dealing with special symptoms are particularly valuable for reference.

Some of the special features of the book are:—

(1) The author's method of casting the diagnostic net;

(2) Evaluation of the laboratory tests and radiography which are indispensable in many cases and in others of great help; but wherever they are employed merely as a short-cut to avoid thinking, they are a menace;

(3) The importance of differentiating organic from functional diseases in the abdomen;

(4) The importance of intestinal neurosis with special reference to the type of the patient;

(5) The author's condemnation of the abdominal belt as a support for cases of visceroptosis;

(6) The importance of upper abdominal pain in cardiac diseases which may even amount to abdominal angina;

(7) An exhaustive study of Dyspepsia in all its aspects;

(8) The pitfalls and limitations in the diagnosis of right iliac fossa pain, which may be avoided by a proper study of the diagnosis of appendicitis;

(9) The extremely interesting and instructive manner in which Backache is treated from its various aspects, well tabulated and well illustrated by a valuable sketch;

(10) The exhaustive way in which the last few sections are dealt with such as

Hæmatemesis, Ascitis, variations and appetite, loss of weight, jaundice, vomiting and pyrexia, abdominal diseases.

The book is well worth reading both by the Specialist and the post-graduate.

A. L. M.

Field Determination of Rocks. By E. H. Davison, B.Sc., F.G.S. (Chapman & Hall, Ltd., London), 1938. Pp. 87 + viii. Price 7*s.* 6*d.* net.

In writing this book the author has evidently kept in view the needs of the field geologist and the prospector to whom a simple method of classification of rocks in the field without any intensive study requiring an elaborate equipment is of utmost importance. With this end, after a few hints on suitable equipment for field-work, the author gives a descriptive list of all the important rock-forming minerals, primary and secondary, which the field geologist is likely to meet with in his rock studies and which he has to recognise for purposes of his classification. Indicating the main forms in which the several types of igneous rocks occur in the field and the structures which they individually show, the author describes, in some detail, the essential characters of the different types and their mode of origin and classification. It is well known that no single system of classification of igneous rocks has been found to be thoroughly satisfactory. The author, however, for his purpose adopts the classification based on readily recognisable characters, such as mode of occurrence, structure, and mineral composition. Such classification may not by itself be sufficiently accurate from an academic point of view, and those who desire to go further and try to identify the several types and sub-types are well advised to supplement their studies with microscopic and chemical investigations in the laboratory. The author gives also, in the succeeding two chapters, the main characters of the sedimentary and metamorphic rocks.

The book is illustrated with 4 text-figures, and 10 plates showing well chosen structures of different rock types. It should prove highly useful to the field geologist and the prospector and should form a useful companion volume to *Field Tests for Minerals* published by the same author.

B. Rama Rao.

An Introduction to Botany. By J. H. Priestley and L. I. Scott. (Longmans, Green & Co., London), 1938. Pp. 615. Price 17*s.* 6*d.* net.

An Introduction to Botany, written by Professor J. H. Priestley and his colleague after several years of experience both in teaching and in research, is expected to contain many novel features in the treatment and presentation of the subject-matter with which it deals and as one goes through the different chapters of the book one feels that this expectation is more than fulfilled. There are many points of interest which strike one as original and new as the book is perused, but there are some features which are very important and mark a departure from several similar books published before.

The student is initiated, by gradual steps, to the study of form and structure of plants. He is first made to study plants as they appear to his naked eye. He is then made to see and study features which he cannot see with unaided eye, by the use of a lens, and finally with the help of a compound microscope. Thus his power of observation is gradually trained so that he is soon able to differentiate the anatomical peculiarities of different parts of the plant.

Another important feature of the book is that the structures and functions of the different parts of the plant are not dealt with separately but both are so blended together that the functions of a tissue or an organ is always associated with its histological features in the mind of the student. Thus the study of the external and internal morphological characters of a plant does not become a study of meaningless terms only to be crammed up for passing a test but it becomes a study of a living organism. The student is able to see and understand the plant as a whole, as one living unit, however complex, made up of parts which are interdependent and interrelated.

Though the book is meant for the use of First Year students, all the recent advances in plant sciences like the discovery of auxines and of the structure of cellulose and starch, are briefly summarised in a concise and intelligible form. The book can, therefore, be read with advantage by students taking degree courses in Botany and by laymen, who wish to know something about plant life which sustains them on this globe.

The book is well written in a simple and unambiguous language and is well illustrated. It tells, in brief, everything that is worth knowing about plant life in general and about flowering plants in particular.

R. H. DASTUR.

The Physiology of Plants. By William Seifriz. (John Wiley & Sons, Inc., New York; Chapman & Hall, London), 1938. Pp. 315. 17*sh.* 6*d.* nett.

The book is written for the use of the college student who has a background in general Botany, Physics and Chemistry. An encyclopædic assemblage of facts is not attempted as any such attempt will restrict its utility to the research worker. The book consists of 26 chapters extending over 302 pages. A few bibliographical references are given at the end of each chapter for purposes of collateral reading.

In the first chapter which is the introduction, the aim, scope and historical background of plant physiology are discussed. The various types of mechanisms and the forces involved in the 'Ascent of water' are thoroughly and concisely discussed in Chapter VII. The recent experiments of Dr. Philip R. White, in which he was able to measure directly the pressures developed in roots grown in culture and the light they throw on Root Pressure as one of the forces involved in the ascent of sap, are included in the chapter. The author has also presented in a simple and clear manner all the more recent outstanding researches such as vernalization, hydroponics, tissue culture, hormones, etc. Thus in Chapter XIX a succinct and exhaustive summary of the rapidly increasing work on Hormones and Growth Regulators is given. The recent success obtained in making isolated root-tissue to grow as an autonomous unit, and the new method of crop production in liquid culture media are described in Chapter XXI. The author has maintained throughout the book a lucid and fluent style.

The book would, undoubtedly, enable the college student to acquire a good grasp of the principles of plant physiology. Its use in colleges is therefore to be recommended.

R. SANKARAN.

Protozoa - Sporozoa. By B. L. Bhatia. *Fauna of British India Series.* (London, August 1938.)

The first volume on Protozoa dealing with Ciliophora in the *Fauna of British India Series* by Principal B. L. Bhatia, published in 1936, was reviewed in this Journal in October 1936 (Vol. V, p. 218). The present volume deals with the Sporozoa and completes the Protozoa. This group includes numerous organisms which are parasitic on hosts belonging to a number of phyla of the Animal Kingdom. Several of them are responsible for producing various diseases in man and domestic animals, and are consequently of great importance for medical and veterinary workers. Numerous others, while causing damage, in various degrees, to various tissues of the hosts, both vertebrates and invertebrates, are not dangerous to the hosts to any serious extent. The author has carried out detailed work for elucidating the correct zoological position and nomenclature of the pathogenic organisms, and as there is a certain amount of difference of opinion in regard to these very difficult questions, he has stated in detail "the argument or the authorities" on which he has relied for his conclusions.

As in the first volume, he has followed the most approved and up-to-date system of classification, and in the Identification Tables of Families he has included all the families, although several of them are at present unknown from India. For the Indian limits he has included the species known from India proper, Burma and Ceylon. In all 320 species are described in the volume and these, as the author rightly remarks, only form a very small fraction of the total known from other parts of the world. In the Introduction he deals with the position of Sporozoa in the Animal Kingdom, their general organisation and structure, phylogeny and classification, and includes a study of the group in India dealt separately under various orders, a short account of their distribution followed by two detailed lists of the parasites and their hosts and *vice versa* of the hosts and their parasites, and finally a short chapter on the technique of studying these interesting types.

How rapid is the progress of work on these organisms is apparent from the fact that since the major part of the work was set up, an addendum dealing with 13 additional

species had to be printed to complete the information.

The descriptions of various species are very detailed, and, in most cases, are illustrated by drawings of all genera and, if possible, of typical species. In addition, two coloured plates at the end of the volume add to the value of the work. A very detailed bibliography of almost 100 pages, arranged under various orders, is included at the end of the publication.

This volume on the Sporozoa should further stimulate work on this very important group of Protozoa, and both the author and the editor are to be congratulated on a very valuable addition to this valuable series on the Fauna of India. B. P.

Scoliodon (The Shark of the Indian Seas). By E. M. Thillayampalam. *The Indian Zoological Memoirs on Indian Animal Types,* II. Second Edition. (Lucknow Publishing House, Lucknow), December 1938. Pp. xiv + 126, 94 text-figs. Price Rs. 2–8.

Over 10 years ago, when this excellent Memoir was first published, it was rightly praised in scientific journals for the great deal of original work and wealth of general information contained in it. In the revised and enlarged edition, now published, Dr. Thillayampalam seems to have spared no pains to bring the work up-to-date by carefully pruning the existing material, by incorporating the results of latest investigations on Elasmobranchs, and by a rearrangement of the matter and its division into definite chapters. The thought and care thus devoted has rendered the treatment of this difficult subject much more lucid and comprehensive.

In the revised edition Professor Grace White's classification of Elasmobranchs replaces the older and more familiar classification of Garman, but fortunately the family position of *Scoliodon* remains unchanged. Of particular interest is the inclusion of a summary of the very valuable results of the investigations of Professor J. Gray on the locomotion of fishes. The nomenclature of blood-vessels has also been revised in the light of Dr. C. H. O'Donoghue's work. Additional information on such subjects as the physiology of blood-vascular system adds to the utility of the Memoir.

By limiting the bibliography to a few important references to publications within the easy reach of university students and by increasing the number of text-figures the usefulness of the Memoir has been greatly enhanced.

If any general criticisms are to be made, they are that the introductory chapter should have been entitled "Introduction and Classification", since this section deals mainly with the classification of fishes, particularly of Elasmobranchs, and with the distinguishing characters, and includes a key to the Indian species and history of the genus *Scoliodon*. In using 'Ventral median fin' instead of the popular term 'anal fin' some better argument should have been given than merely saying that "this name is not appropriate".

The revised and greatly improved edition of the Memoir on *Scoliodon* will not only be of use to Indian students in their laboratory work, but should also be invaluable to research workers all over the world interested in comparative studies of the various Elasmorbranch types. The reviewer will be lacking in his duty if he failed to congratulate Dr. Thillayampalam and the Editor, Professor K. N. Bahl, for this excellent production in a series of extremely valuable memoirs. S. L. Hora.

La Probabilite dans les differentes branches de la Science. By G. Castelnuovo. (Actualités Scientifiques et Industrielles No. 563. Hermann & Cie., Paris), 1937. Pp. 61. Price 12*fr.*

In this brochure Prof. Castelnuovo gives a general account of the meaning of probability and its applications to Statistics on one hand, and to Theoretical Physics on the other. In the first chapter the two kinds of probability—*a priori* and *a posteriori*—are introduced and explained. The Gaussian error law is discussed in the second chapter. The third and the fourth are devoted to the applications to statistics and theoretical physics respectively. The exposition is throughout in that clear and direct style so characteristic of Prof. Castelnuovo's writings and is enlivened by judicious and opportune historical references. The book may be heartily recommended to all who wish to obtain a bird's-eye-view of this increasingly important subject. V. R. T.

Stellar Dynamics*

THE recent publication of the book with this title by Prof. Smart can well be considered as a landmark in the development of this very important branch of Astronomy. Books written on a rapidly growing subject can be placed generally in two classes, those of a pioneering character, and those of a consolidating nature. Two remarkable books of former type on the two important subjects of Astrophysics and Stellar Dynamics have been written by Eddington, and are well known to workers in Astronomy. These books written early in the history of the development of the subject were in no small measure responsible for its further rapid progress, and for this very reason have become rather out of date as *text-books*. This is specially true of Stellar Dynamics since Eddington's book *Stellar Movements* was written just a decade after the birth of the subject itself, and the last quarter of a century has brought great and important additions to our knowledge of the subject. In so far as Astrophysics is considered, the want of text-books of a consolidating type has been met by the books of Rosseland and Unsöld. For Stellar Dynamics, the gap is now admirably filled by the book under review.

One finds some nearly three hundred references, in the footnotes, to papers published in several journals by the foremost workers in the field. This vast amount of material is suitably condensed and in many cases improved upon so as to suit the logical presentation of the subject. The author has achieved striking success in presenting, for the first time, a systematic account of Stellar Dynamics, and there is no doubt that this book will be extremely helpful in encouraging further research in many directions.

The book could be roughly sub-divided into three parts, *viz.*, Stellar Kinematics, Stellar Statistics and Stellar Dynamics, with an introduction devoted to the essential preliminary notions of Astronomy. The book is complete by itself, and does not presuppose any preliminary knowledge on the part of the reader except, perhaps, an acquaintance with a text-book on Astronomy like the excellent one by the author himself.

The Introduction, though short, is quite comprehensive, and contains all the necessary preliminaries. A general description of the galactic-system is followed by the explanations of the fundamental notions of modern Astronomy like spectral type, stellar magnitudes apparent and absolute, parallaxes, proper motions, radial velocities, masses, solar motion and galactic latitude, stellar evolution and the time-scale. It is quite appropriate, as an emphasis on the importance of the subject, that the author should include in the introduction itself a treatment of statistical notions like the correction of observed frequency curves, and mean values.

The next four chapters deal with the kinematical part, and exhaustive investigations are given of the theory of two star-streams, Schwazschild's Ellipsoidal theory and the solar motion. The mathematical treatment is greatly simplified by prefacing the discussion with a chapter on a single star drift, and the work in this chapter on the mean stellar speeds, T, R, W, and the formula for the drift curve by a Fourier series greatly facilitate the presentation of the two-star stream theory. In discussing this last theory special attention is given to technical details relating to the analysis of observational material. Probably the chapter on the Ellipsoidal Theory is the most beautiful in the book, while that on the solar motion is the most complete. Particular mention might be made of the general treatment of proper motions on the Ellipsoidal Theory, and the illustration of the analysis from a particular region of the sky, as also the determination by Smart and Green of the solar apex, and solar motion.

The statistical part consists of two special investigations followed by a chapter on general theorems of stellar statistics. The particular characteristics of stars, *viz.*, statistical parallaxes, and the space distributions of stars are first discussed by making suitable assumptions regarding the law governing the distributions of these characteristics. The important work of the author on the treatment of the density law of space

* *Stellar Dynamics*. by W. M. Smart, M.A., D.Sc., Regius Professor of Astronomy in the University of Glasgow. (Cambridge University Press), 1938. Pp. 1–429. Price 30*s*.

distribution on the ellipsoidal hypothesis is presented here in full detail. General theorems on stellar statistics are brought together in the eighth chapter, which explains the important work in this field done by Schwarzschild, Kapetyn, Eddington, Van Rhign and others.

The fundamental work of Jeans and Eddington on Stellar Dynamics is dealt with in the tenth chapter. The fundamental principles of the subject, the fundamental equations in several systems of co-ordinates, the theorems of Jeans and Eddington, the cases of spherical and cylindrical symmetry, the hydro-dynamical equations, the recent work of Shiveshwarkar, and the deduction of the possibility of star-streaming are some of the topics in a chapter which is rich in theoretical investigations and suggestions for further work.

The culminating portion of the book is, of course, the topic of galactic rotation. This is treated from the observational standpoint in the eleventh chapter whereas the last chapter deals with the theoretical aspects of galactic dynamics. This last chapter is undoubtedly the most important, and contains all the recent work on the galactic system. The relation between galactic rotation and star-streaming, and the derivation of the ellipsoidal distribution of stellar velocities are beautiful examples of the application of the general theorems of Stellar Dynamics to galactic rotation. The proof of the asymmetry of stellar motions by pure dynamical theory can well be considered as one of the triumphs of Stellar Dynamics. The limitations of the theory are also brought out in the investigation of the differential effects for radial velocities and proper motions, and the direction of star-streaming as consequences of the rotation of the galaxy about the galactic centre. The book concludes with an account of Oort's work on the density of dark matter in the neighbourhood of the Sun—a typical example of what modern Stellar Dynamics has been able to achieve.

A very useful appendix of astronomical constants is to be found at the end of the book, where it is very gratifying to find the Oort's constants A and B in company with aristocratic constants like the constant of gravitation, and the velocity of light!

Dr. Smart has written an extremely well-balanced book without omitting any relevant important work or without going off at peculiar radial speeds in particular directions. We might say with a zero "factor of exaggeration" that this book will at once become the standard work on the subject and remain so for a long time to come.

B. S. MADHAVA RAO.

Theosophy and Science Shake Hands*

IN the *Current Science* for August 1938, I had noticed the first volume of the series entitled "Where Theosophy and Science Meet" issued under the general editorship of D. D. Kanga, in which the ground, scientific and theosophical from "Macrocosm to Microcosm" had been surveyed, and the second volume under notice sketches, as it were, the progress from "Atom to Man". The volume opens with a contribution on "Matter and the Atom" by G. Monod-Herzen who points out that neither theosophy nor science "is yet complete", but both reveal the factor of progress, "an infinite succession of ignorances". The claim is advanced that "Theosophical observers revealed the existence of isotopes before the physicists did so" (p. 26). The second article is contributed by D. D. Kanga in which an attempt is made to show "where and how far Theosophy and Chemistry meet" (p. 29). After explaining the "septenary system" on which the Universe, according to Theosophy, is based, the author examines what Chemistry has to say, summing up the epoch-making discoveries of modern science". 49 sub-planes constitute the physical universe and man. Of these, scientific activity and research are restricted to just *three*. "It is only there that Theosophy and Science can meet" (p. 56). Then follows an article on "Physics" (Light, Sound, etc.), by R. D. Kanga. The author points out or claims that the modern "physicists have unconsciously entered into the region of metaphysics" .....(p. 86). The next contribution on "Relativity" is by Shyama Charan, as also the succeeding one on "Modern Mathematical Thought" in which the strange

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* *Where Theosophy and Science Meet.*—Part II. Edited by D. D. Kanga. (Published by the Adyar Theosophical Library), 1938. Pp. 169. Price Re. 1-14-0.

equation is sought to be demonstrated that *one is equivalent to two* (p. 115). Then follows the contribution on "Evolutionary Biology" by Margaret A. Anderson, at the conclusion of which reference is made to the "next great race ..... destined to mount from the present ..... to the cosmic or intuitional level of consciousness" (p. 143). The concluding article on "From Mineral to Man" is by Corona G. Trew, who explains that "Mineral, plant and animal, three kingdoms are needed before self-consciousness is born" ..... (p. 157).

As I have indicated at some length, the arguments in my previous review on the basis of which I believe there is no need, practical or speculative, for any meeting between Theosophy and Science or Sciences, I do not propose to refer to them here, but, I would emphatically repeat the truth that any artificial meeting or *rapprochement* between Theosophy and Science must end in complete effacement or distortion of the distinctive individuality of both. My conviction is strengthened by a perusal of the second voulme under notice. The contributors sum up or bring together the results of the different sciences and argue that most, if not all, these results are found anticipated in the writings of Madame Blavatsky, especially in the *Secret Doctrine*, from which statements and *obiter dicta* are quoted.

I desire to make only one comment. The advantages of sciences and scientific investigation in the shape of Radio, Air-navigation *et hoc* have been placed within the reach of all on a scale of commercial distribution. When, however, I am told that there are still 46 sub-planes to be investigated, I am entitled to demand that I be let into the secret of these *planes* as legitimately as an inquirer would demand, say, light on the mechanism of the locomotive. Laboratory verification and commercial distribution would be the crux. In that crux-land, Theosophy and Science *emphatically do not meet*.

With great respect, I would like to make a present of the following to Sir C. V. Raman and other scientists. The writer on "Relativity" remarks quite sincerely, rather pathetically, I should suppose—"We do not know what is the nature of Light. We do not know what is the nature of Gravitation. We do not know what is the nature of Space-Time". I would like to put every sentence in italics. Whether the scientists know anything about Light or not, I do know that the *Advaitic dictum*, "Brahma-Satyam-Jaganmithya - jeevo - Brahmaiva-na-aparah" has nothing whatever to do with *Relativity* as understood and interpreted by Einstein and challenged by Sir Suleiman, I believe.

Nor am I convinced about the theoretical soundness or invulnerability of the so-called "Occult method", or practical application thereof making any standing or substantial contribution to the solution of any of the problems confronting modern mankind. There may be a "Scientific League of Nations" which Ritchie Calder wants, but, seeing the fate that has overtaken the League of Nations, similar leagues, even of scientists, must be deemed suspect. I also note that D. D. Kanga wants a Chair in Occultism in all the principal Universities of the world. In matters of advanced research, the Madras University always takes the initiative. I can only hope before the third volume is on the Editor's table at the *Current Science* Office, the Madras University would have established a Chair of Occultism, and appointed a proper Professor. Be that as it may, I detect a small typographical error in the text of *Brihad-aranyaka* on page 94.

R. NAGARAJA SARMA.

CENTENARIES

By S. R. Ranganathan, M.A., L.T., F.L.A.

(*University Librarian, Madras*)

Regaud, Stephen Peter (1774–1839)

STEPHEN PETER RIGAUD, a British astronomer, was born at Richmond in Surrey, August 12, 1774. His father was observer to the King at Kew, which is believed to have influenced the tastes and predilections of his son. He was educated at Richmond and Oxford and became M.A. in 1799. He was appointed reader in experimental philosophy and Savilian professor of geometry in 1810. He succeeded his father in 1814 as observer to the King at Kew and became Radcliffe observer in 1827. These posts he held till his death.

Rigaud made nineteen valuable contributions to the *Transactions* of the Royal Astronomical Society and to other periodicals. He was responsible for the addition of a new transit circle to the Radcliffe Observatory. He succeeded in persuading William IV to erect a monument to Bradley at Kew.

Rigaud is perhaps best remembered for his contributions to the history of mathematics and astronomy. In 1831 he published the *Miscellaneous works and correspondence of Dr. Bradley*. To this he added a supplement in 1833 which incorporated the astronomical papers of Harriott. He also published in 1838 a *Historical essay on the first publication of Newton's Principia*, in which he explained how Newton might have been led to give an erroneous value to the radius of earth. He also made extensive preparation for a life of Halley and a new edition of the works of Pappus. The first volume of his *Correspondence of scientific men of the seventeenth century* was printed just before his death, while the second volume came out posthumously in 1841.

He was elected Fellow of the Royal Society May 30, 1805 and was its Vice-President in 1837–38. Rigaud died in London March 16, 1839.

Colburn, Zerah (1804–1839)

ZERAH COLBURN, an American mathematical prodigy, was born in Cobot September 1, 1804. His father was a poor man with a large family of nine children. Zerah showed remarkable powers of calculation before he was six and his poor father tried to liquidate his poverty by exhibiting his son.

Having met with success in America he set out in 1812 to England where his prodigious son was admired by royalty and nobility. But Paris gave him a cold reception and the father lost heavily by his travel through France.

During 1816–19, Zerah was sent to the Westminster School under the patronage of the Earl of Bristol. But on the suspicion that the Earl was diverting some funds due to him, the father quarrelled with him and, plagued by poverty, induced his son to redeem their fortunes by a career on the stage. Failing there, he became a school master and ultimately returned to America in 1824, after his father's death. Even there he had only a chequered career, first being a minister till 1835 and then a teacher for the remaining four years of his life.

In 1833 Zerah published his autobiography entitled *A memoir of Zerah Colburn written by himself*. His arithmetical ability is said to have remained with him throughout his life. Leaving his widow and six children behind, he died of tuberculosis March 2, 1839.

Binnie, Alexander Richardson (1893–1917)

ALEXANDER RICHARDSON BINNIE, a British engineer of the Indian Engineering Service, was born in London March 26, 1839. Having received his general education privately and his engineering education from Bateman, he took up an appointment in 1862 in connection with the construction of new railways in Mid-Wales.

In 1867 he came to Nagpur as executive engineer. During his period of service he carried out the works for the supply of that city with water from Ambajheria, about four miles distant. He also made discoveries of coal in the Chanda District. This led to the construction of a railway and the opening up of the coalfields.

Having served as the Chief Engineer for water works to the City of Bradford from 1875 to 1890, Binnie became Chief Engineer to the London County Council. This position he occupied for nearly twelve years when he constructed the Blackwell and Greenwich tunnels under the river Thames, constructed the Barking Road Bridge and commenced the Vauxhall Bridge. He also reported on the reconstruction of the London drainage and widened the Strand, Aldwych and Kingsway.

After retirement from the London County Council, Binnie commenced private practice with his son as a partner. The works that engaged his attention during this period were the Arterial Drainage of Ireland, the water-supply of Malta, the water-supply and drainage of Petrograd and the water-supply of Ottawa.

His paper on the *Nagpur water works* is of interest even now. His paper *On mean and average rainfall and the fluctuations to which it is subject* won for him a Telford and a George Stephenson Medal.

On the completion of the Blackwell Tunnel he was Knighted and in 1905 he was elected President of the Institution of Civil Engineers.

Binnie died at Beer May 18, 1917.

Tata, Jamsetji Naserwanji (1839–1904)

JAMSETJI NASERWANJI TATA, an Indian pioneer and patron of scientific research, was born at Naosari in Gujerat March 3, 1839. After studying in the Elphinstone College, Bombay, for three years, Tata entered his father's business and set sail to China in 1859 to further their export business.

Turning his attention to the cotton industry in Bombay, Tata first studied the conditions of

Lancashire mills and later established his own Empress Mills in Nagpur January 1, 1877. In 1896 he published a monograph on *Growth of Egyptian cotton in India* and sought to acclimatize Egyptian cotton in India. The inauguration (1893) of the Japanese Steam Navigation Co., the promotion of the Tata Iron and Steel Co. (1907), and the far-sighted inspiration of the Bombay hydro-electric schemes have been sufficient causes to accord Tata a foremost place among the pioneers of Indian industry.

While quietly doing many deeds of kindness, Tata never indulged in promiscuous charities which are but a temporary relief to the inefficient. Convinced of the deficiencies of higher education in India, he inaugurated in 1892 a scheme by which a few promising young Indians were sent to England to qualify for higher administrative and technical services. He was proud of his scholars, "Our young men," said he, "have proved that they can not only hold their own against the best rivals in Europe on the latter's ground, but can beat them hollow".

Tata realised that the course of study in the Indian Universities stifled originality and initiative. His remedial plan took shape as an offer to Government of India on September 28, 1898 of property in Bombay estimated to yield an annual income of Rs. 1,25,000. He also deputed a promising young man, Burjorji Padshah, to European seats of learining to find out the most productive use for the endowment. "What advances a nation or a community is not so much to prop up its weakest and most helpless members as to lift up the best and most gifted so as to make them of the greatest service to the country," so said Tata and started with Padshah's provisional scheme to work out his remedial plan. Its final form took shape as the Indian Institute of Science, Bangalore, "an institution devoted to post-graduate study and research, particularly in science, and conducted with a view to the application of science to Indian arts and industries, with a constitution resembling that of a University.

Tata refused to accept the proposal that the Institution should be named the Tata University, though his contribution towards its establishment amounted to 30 lakhs of rupees. The Institute began its work July 24, 1911.

Tata died at Nauheim, a German watering place May 19, 1904.

ASTRONOMICAL NOTES

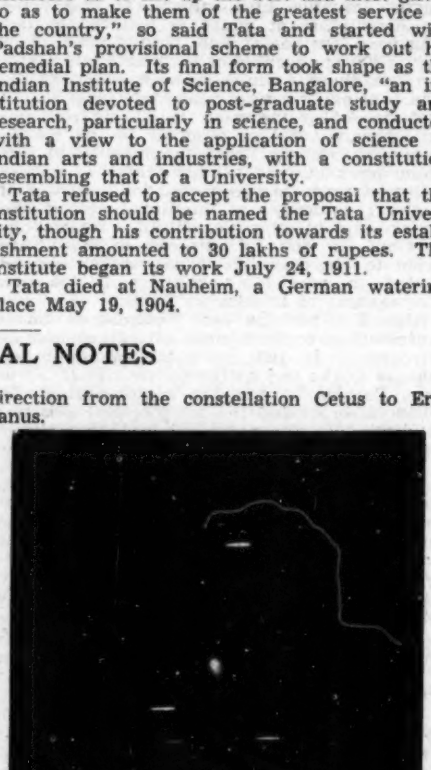
Solar Eclipse.—An annular eclipse of the Sun will occur on April 19, but the phenomenon will not be visible in India. The path of the annular eclipse lies towards the extreme north —in the Arctic Ocean and the north-west part of North America.

Planets during April 1939.—Mercury is in inferior conjunction with the Sun on April 3; and during the latter part of the month it can be seen low down near the western horizon at about sunset. Venus will continue to be visible as a bright morning star for nearly two hours before sunrise; it is slowly moving towards the Sun and becoming fainter. Mars, rising about midnight, will be well placed for observation during the late hours of the night; its brightness is increasing, the stellar magnitude being $-0{\cdot}2$ at the end of the month.

Jupiter, although not in a favourable position for observation, can be seen as a morning star rising about a couple of hours before the Sun; on April 22, there will be a close conjunction of the planet with Venus which is worth observing. Saturn passes conjunction with the Sun on April 11 and at the end of the month, will be just visible near the eastern horizon.

A lunar occultation of interest, that can be observed in India is that of the first magnitude star Spica (α Virginis) which will occur on the night of April 4–5, about an hour after midnight.

Comet Cosik-Peltier (1939 *a*).—As indicated by the ephemeris, the comet became somewhat brighter. On February 8, the magnitude was 5·8, just bright enough to be seen with the unaided eye. The object was diffuse with a sharp nucleus, and had a conspicuous tail over a degree in length, which was well visible with even small instruments. At the time of closest approach to the earth, the distance appears to have been about 50 million miles. The comet has been moving rapidly in a south-easterly direction from the constellation Cetus to Eridanus.



Comet Cosik-Peltier (1939 *a*)

Taken at the Nizamiah Observatory, Hyderabad.—Feb. 14, 1939. Exposure: One hour, ten minutes.

The Photograph was taken with a 4½ inch astro camera attached to the astrographic equatorial The images of stars in the region are shown as short trails due to the motion of the comet relative to the stars during the time the exposure was made. The tail appears to be about a degree in length.

T. P. B.

Agricultural Research in India

THE Imperial Council of Agricultural Research has, since its inception in 1926, identified itself to an increasing extent with the course of agricultural research all over India. The latest Report of the Council, for 1937–38, gives a good indication of the rapid growth that has taken place in the Council's research activities during the last 5 or 6 years. The Council has at present on its hands over a hundred schemes and is maintaining a staff of over 300 research officers. The total expenditure on these schemes came to over Rs. 17 lakhs, during the year under review, out of which Rs. 4·25 lakhs were earmarked for sugar research and were spent, partly for the maintenance of the Imperial Institute of Sugar Technology at Cawnpore and partly to finance various schemes relating to the improvement of the sugar industry in different parts of the country. The other major activities, which consume over a lakh of rupees per head, are marketing schemes (2·56 lakhs), veterinary and nutrition research (2 lakhs), fruit research (1·11 lakhs), cold storage (1 lakh) and rice research (1 lakh). About 78 thousand rupees were spent on locust research, 71 thousands on wheat and barley, 47 thousands on oil seeds, including a sum of 15 thousands given to the Harcourt Butler Technological Institute, Cawnpore, 46 thousands on potato, 14 thousands on tobacco and about 20 thousands for studies on soils and manures. Among other items, may be mentioned a sum of Rs. 25,900 spent to maintain the botanical sub-section at Pusa, a sum of Rs. 22,600 given for the Agricultural Meteorological Section at Poona, and 58 thousands given as grants to various scientific bodies outside India.

The great prominence till now given by the Council to researches connected with the sugar industry has no doubt been amply justified by the remarkable results achieved in developing the industry during the last 5 or 6 years, but the sugar boom is now practically ended and there is no reason why the further development of the industry should not be left to a special Sugar Committee, similar to the existing Cotton, Jute, Coffee, Tea and Rubber Committees. Sugarcane is probably the last of our agricultural booms, and it is unlikely that we shall witness any further examples of sudden large-scale development in a crop, except probably to a limited extent in oil-seeds, fruits and rice.

The most pressing problem, however, which would demand the Council's serious attention in the near future would consist in devising measures for increasing the production-capacity per acre of the present area under cultivation, for extending the area if possible and for setting up an organisation which could secure the best return to the cultivator for the produce of his land. The production value per acre in India is, as is well known, notoriously low when compared to other countries such as Italy, Spain, Holland, etc. It could be inreased only by better and judicious manuring of the crop, by greatly extending the present irrigation facilities and by popularising the use of improved strains. It may be said that most of this work properly falls within the ambit of the provincial governments, but there are several problems involved in the programme, which require to be studied on an all-India basis and the Imperial Council of Agricultural Research could best act as the co-ordinating agency which could tackle such problems, avoid overlapping and supplement local resources.

For securing the best utilization of the present area under cultivation and for reclaiming the areas at present designated as "cultivable wastes", it is necessary to have a preliminary All-India Soil Survey, on a properly predetermined plan. This could best be carried out under the auspices of an all-India body such as the Council, with the co-operation of provincial governments.

In this connection, the recent remarks of Sir John Russell in reviewing the work of the Imperial Council of Agricultural Research, may also be kept in mind, especially his plea for bridging the gulf between the laboratory and the field and for placing the question of increased productiveness as the central problem before the country. Among the other problems awaiting more systematic attention in the near future, Sir John has mentioned those relating to the improvement of the quality of food-stuffs, development of the dairy industry and encouragement of fruit and vegetable cultivation —all directed towards securing an improvement in the diet of the Indian people.

Sir John has also recommended a more systematic study of irrigation problems and of water relations between soil and crops, of questions relating to erosion and maintenance of soil fertility—all of which could best be dealt with by an All-India Soil Conservation Committee.

At present, the resources of the Imperial Agricultural Research Institute are not fully utilized for tackling the several fundamental and applied problems, which the Council has to solve. Though some problems of a purely academic type could best be given over to Universities and other scientific institutions scattered over the country, in order to create a general interest in them in agricultural research, there are numerous other problems closely interleaved with practical agricultural conditions, *e.g.*, those relating to soils, manures, plant breeding, plant diseases, quality of crops, etc., which could best be tackled at a central Agricultural Institute such as the one at Delhi.

Another direction in which the Council could usefully extend its activities, lies in efforts at securing a better price to the cultivator for the produce of his land. This may be done by a more efficient system of marketing—beginnings of which have been already made by the Council—and also by finding other industrial outlets for agricultural produce. This latter aspect is already engaging the serious attention of economists and agricultural experts in West-

ern countries. Though India could usefully consume a much higher proportion of food materials than she produces at present, still in view of the depressed market for cash crops such as cotton, rubber, coffee, tea and sugar-cane, and the early possibility of an all-round increase in the production capacity of our land per acre due to better manuring, increased irrigation facilities, etc., there is bound to be an increasing excess of agricultural production over consumption and the problem of how best to utilize the excess must be faced.

Agriculture is the chief industry of India and there is no reason why more efforts should not be made to find industrial outlets for our agricultural products. Space does not permit a discussion of the methods adopted in America, Germany and elsewhere in order to tackle this problem. Already the Imperial Council of Agricultural Research have got a few schemes of an Agri-industrial nature such as the malting of cholam, but further scope in this direction is immense. C. N. A.

Indian Forest Mycology with Special Reference to Forest Pathology*

WORK done in India on forest tree diseases and the peculiar problems which they present have received little publicity and Dr. K. D. Bagchee, who is investigating them at Dehra Dun, dealt, in his Presidential Address to the Botanical Section, at considerable length, with what has been so far accomplished. In forest tree disease investigations, the root and stem rotting fungi, the canker pathogens, the nursery diseases and the rots of timber call for attention but none, perhaps, gives more anxiety to a forest mycologist than the rusts which cause a great deal of damage to young plantations, especially of conifers.

In the case of root and stem rotting fungi, the discovery of the primary pathogens responsible for the rots is of great importance. Bagchee finds that the rots, in more cases than one, are the result of the combined action of several fungi and bacteria, as in the case of the *gauj* disease of *sal* in the U.P. Terai. In the root-rot disease of *shisham*, he has definitely discovered that the primary organism of the disease is a species of *Fusarium*, though the fruiting bodies of *Ganoderma lucidum* and *Polyporus gilvus* have been invariably found at the base of dead or dying trees. Controversies regarding the pathogenicity of some root- and stem-rotting fungi have been finally set at rest, for Bagchee has shown that *Fomes annosus*, *Armillaria mellea* and *Trametes pini* do play an important rôle in bringing about some of these rots.

But the most important work done during the past decade on forest tree diseases mainly concerns itself, however, with the rusts. Bagchee reports that there are fifteen rusts affecting the conifers alone in our Northern Indian Forests. As a rule, these are heteroecious and have their æcial stages on the narrow-leaved conifers and the telial stages (or the perfect stages) on the broad-leaved plants, usually dicotyledons. Intensive study by Bagchee of the two rusts, *Chrysomyxa deformans* and *C. piceæ* on *Picea morinda* and of another *Chrysomyxa* sp. on *Pinus excelsa*, whose telial stages, strangely enough, occur not on the broad-leaved dicotyledonous plants but on the conifers themselves and whose æcial stages have not so far been discovered, has led to the inevitable conclusion that these rusts have adopted a microcyclic mode of existence abandoning the necessity of passing from one host to another to complete their life-cycles, as they are able to perennate in the mycelial form within the coniferous hosts.

In rusts which are not microcyclic, one of the important tasks of a mycologist is to find out the alternate hosts where the telial stages occur. Bagchee has been singularly fortunate in being able to establish this in three cases, the most important discovery being the matching of *Peridermium brevius* with a species of *Coleosporium*, which Bagchee proposes to name as *C. barclayense*, found on *Senecio rufinervis*.

It must not, of course, be supposed that all fungi found in the forests are harmful. Their rôle in converting leaves, logs, roots and other plant debris into humus and their part in renovating and enriching the resources of nature for the life and growth of new things, have been also briefly referred to. M. B.

* Summary of the Presidential Address (Botany Section) by Dr. K. D. Bagchee, D.Sc., D.I.O., F.N.I., Indian Science Congress, Lahore, 1939.

SCIENCE NOTES AND NEWS

The Complete Solution of the Plateau Problem.—J. Douglas who was the first to have given a complete solution of the Plateau Problem of the existence of the minimal surface with a single contour has now published his partially proved and announced results concerning a very profound generalisation of the problem (*Annals of Math.*, 1939, 40, 205–98). The generalisation consists in proving the existence of the minimal surface bounded by any number of curves $\Gamma_1, \Gamma_2, \ldots \Gamma_k$ and which is of prescribed genus (deficiency or the 1st Betti number r). Courant has also proved the same but has not completely published his proof.

Douglas starts with the well-known conformal representation of the minimal surface due to Weierstrass, i.e., to find n harmonic functions

$$x_i = \mathrm{R}\,[\mathrm{F}_i\,(u+iv)], \text{ where } \sum_1^n \mathrm{F}_i'^2 = 0$$

on a domain of Riemann's surface with the same topological structure in such a way that the n boundary curves of the domain are transformed into the given contours in space. (The deficiency of the Riemann's surface is easily seen to be $r+k-1$.) Klein's introduction of a symmetric Riemann's surface is of help here. It is a Riemann's surface with an involution T on itself so that pairs of corresponding points correspond to antipodal points on the minimal surface and the boundary curves correspond identically to themselves by means of the involution. The contours in space have to satisfy certain conditions besides being Jordan curves but may cross one another and they may be oriented in any desired way. It may also happen that a single minimal surface may not exist at all, i.e., the solution obtained gives a number of distinct minimal surfaces whose total boundaries are equal to the set (Γ).

One of the artifices employed by the author consists in employing the Dirichlet integral

$$\mathrm{D}\,(\mathrm{X}) = \iint_{\mathrm{R}} (\mathrm{E}+\mathrm{G})\,du\,dv = \iint \left[\left(\frac{\partial x_i}{\partial u}\right)^2 + \left(\frac{\partial x_i}{\partial v}\right)^2\right] du\,dv$$

instead of the usual surface integral

$$\mathrm{I}(\mathrm{X}) = \iint \sqrt{\mathrm{EG}-\mathrm{F}^2}\,du\,dv$$

which is more difficult to deal with. On account of the identity

$$\tfrac{1}{2}(\mathrm{E}+\mathrm{G}) - \sqrt{\mathrm{EG}-\mathrm{F}^2} = \tfrac{1}{2}(\mathrm{E}^{1/2}-\mathrm{G}^{1/2})^2 + \tfrac{1}{2}\left[\sqrt{\mathrm{E}^{1/2}\mathrm{G}^{1/2}+\mathrm{F}} - \sqrt{\mathrm{E}^{1/2}\mathrm{G}^{1/2}-\mathrm{F}}\right]^2$$

which proves immediately the fact that

$$\mathrm{D}(\mathrm{X}) \geqslant \mathrm{I}(\mathrm{X}),$$

he has proved that the two minimal problems are identical.

The next transformation which is difficult consists in transforming these integrals to line integrals along the contours by finding and employing the Green's function for the domain on the Riemann's surface. Douglas brilliantly extends certain simple identities of the theory of elliptic and θ-functions of one variable to identities in the theory of multiple θ-functions (by means of these and the ρ-abelian integrals of the first kind on the Riemann-surface the Green's function is expressed) and the functions corresponding to the Weierstrassian functions and makes use of them in an interesting way. The advantage of this transformation is this. The Dirichlet-Functional (the area functional is more easy) is more difficult to deal with than the functional formed by the line integrals. He shows that the latter functional is lower semi-continuous and that the total set of all surfaces bounding the contours (omitting certain improper ones) forms a compact set. Hence the existence of the minimal surface follows immediately.

These are only the bare outlines of the proof. The problem is extremely complicated and it is really a pleasure to see that this famous problem of the latter half of the previous century is solved with extreme generality. Almost all types of surfaces (with any topological structure) can be experimentally constructed by means of soap films.

K. V. I.

* * *

The Mesotron.—The probable existence of a new type of particle intermediate in mass between the electron and proton has been suggested by Anderson and Neddermeyer (1937) as constituting the hard component of cosmic radiation. Remarkably enough such particles were postulated by Yukawa (1935) to explain the exchange forces between proton and neutron without introducing the neutrinos as would be necessary on the β-decay theory. It has further been shown by Frölich, Heitler and Kemmer that the heavy electron theory can also be made consistent with the observed magnetic moments of neutron and proton. This intermediate particle has been designated by various workers by different names as heavy electron, yukon, barytron, and mesotron or meson. This last name appears to be the one favoured by most physicists. In the short interval of two years, there has been a very large number of papers written on the mesotron, and it appears to play a very important part in cosmic ray theory. A most important suggestion is that of Euler and Heisenberg that a mesotron can disintegrate into an electron and a neutrino, the heavy mass of the mesotron appearing in its offspring as great kinetic energy. This assumption explains the observation of cosmic ray workers that the hard component is much more reduced in intensity in passing through air than through an equivalent amount of dense lead, as has been shown by Rossi, Blackett and others. Heitler has also shown that the nuclear proton-proton force can be explained by assuring a neutral heavy particle (or *neutretto*), and a new evidence for such a particle has recently been given by F. R. Shonka (*Phys. Rev.*, 1939, 5, No. 1, p. 24) which, however, requires confirmation. Bhabha has pointed out (*Nature*, Feb. 18, 1939,

p. 276) that the theory of the mesotron introduces a fundamental length, and connects this theory with Dirac's recent work on the point electron. The mesotron promises to play a very important part in nuclear theory, and provides ample material for theoretical speculation, adding as it does, a new type of particle intermediate between the light and heavy particles.

* * *

A New Type of Nuclear Reactions.—A new and important type of nuclear reaction has been reported by Hahn, Meitner and Strassman of the bombardment of uranium by deuterium neutrons, and the resulting disintegration leading to the production of a barium isotope ($Z = 56$). This has been confirmed by workers at Columbia University, Carneigie Institute at Washington, and John Hopkins University. Such a reaction would be inexplicable on the older nuclear theories, but appears to be a brilliant confirmation of Bohr's recent theory of nuclear processes as being really double transitions with the formation of a compound nucleus as an intermediate stage. This theory explains very simply the resonance phenomena of nuclear physics, and it has been suggested that the above nuclear reaction of disintegration of uranium by neutrons is such a phenomenon. On Bohr's liquid drop model the disintegration into a Ba-nucleus is exactly like the fission of a liquid drop into two. Further work with thorium is being continued in the same direction.

* * *

A New Stable Isotope.—Another gap in the list of stable isotopes has been filled by the work of Joliot and Zlotowski who report (*J. de Phys.*, T. 1938, 9, No. 10, p. 403) the formation of a stable isotope of helium (He^5) of mass five formed by the collision of He^4 and deuterons. Fuller data regarding the binding energy of this nucleus would add considerably to the theoretical development of the lighter nuclei.

* * *

The Differential Analyser.—This instrument giving a mechanical method for integrating differential equations which are not exactly integrable was devised about eight years ago by Dr. Vannevar Bush of the Messachusetts Institute of Technology. The superiority of this method over all other approximate methods has now been definitely established and the instrument is very widely used in electrical Engineering problems as shown recently by Hartree and Nuttal (*J. Inst. Elec. Eng.*, No. 503). It can also be used with great advantage in calculations with cosmic ray data (see for *e.g.*, Lemaitre and Vallarta, *Phys. Rev.*, 1936, 50, 493; and A. Hunter, *ibid.*, Jan. 1939, 55, No. 1, p. 15). It might perhaps also be mentioned here that Dr. Bush, who has recently devised a new instrument called the "Cinema Integraph", has been appointed President of the Messachusetts Institution.

* * *

Non-Stoicheimetric Oxides.—Until the end of 1933, it was assumed that the complex oxides can be properly formulated in terms of the simpler members of the series, *e.g.*, Cr_2O_{19} was formulated as 3 CrO_3, Cr_2O_2 and Pb_3O_4 as 2 PbO_2. PbO_2. In 1934, Klemm and Hass (*Zeit. Anorg. Chem.*, 219, 82) showed from paramagnetic studies that nickel oxide can never exist as NiO_{1000}. A similar departure from the law of constant proportions appears to be shown by cupric and ferrous oxides, and by ferrous sulphide. It would thus seem likely that the oxides of metals of variable valency are not exactly stoicheiometric compounds, and may also vary slightly in composition between well-defined limits. A. Cameron, E. H. Harhard, and A. King (*J.C.S.*, 1939, p. 55) have studied a large number of oxides of chromium, and find that chromic anhydride decomposes in two stages with the formation of two non-stoicheiometric oxide ranges $CrO_{2\cdot0}$-$CrO_{2\cdot2}$ and $CrO_{1\cdot7}$-$CrO_{1\cdot5}$. Many of the "oxides" reported in the literature hitherto have been shown to be in one or other of these stability ranges.

* * *

The Mould Fungi of India.—Because of their role in decomposing unwanted organic matter and their use in alcoholic and cellulose fermentations, in the preparation of food products, vinegar and other organic acids, the mould fungi affect us very closely. A study of some of these organisms made by Chaudhuri *et al* (*Proc. Ind. Acad. Sci.*, 1938, 8, 79–99) is, therefore, a step in the right direction. The papers are designated "Molds of the Punjab" but information on all the known Indian *Aspergilli* and *Penicillia* is given in the two papers so far published. Of the thirty-one species of *Aspergilli* recorded by Chaudhuri, *Aspergillus polychromous* De Mello is not accepted as a species by Thom and Church (*The Aspergilli*, p. 137), while *A. sachari* Chaudhuri and *A. humicola* Chaudhuri and Sachar are not considered as deserving of separate specific rank by Blochwitz (*Ann. Myc.*, 1935, 33, 240). Blochwitz thinks that the former may be *A. quercinus* and the latter, *A. flavus*, from the given descriptions. The identification of one isolate as *A. calyptratus* is also doubted, which, he thinks, may be *A. fumigatus*. Blochwitz complains that in spite of repeated requests, he was unable to obtain cultures of *Aspergilli* described by Chaudhuri and a similar complaint is made by Thom and Church regarding De Mello's species. The mould fungi are the most difficult to identify. Cultures of moulds, especially of new species, should invariably be deposited in a central place both for the use of specialists for the confirmation of determinations and the industrial chemists who can harness them into some use.

M. B.

* * *

Nephridia in the Indian Leech, *Hirudinaria*.—Our knowledge of the excretory and associated organs of *Hirudinaria* is brought up to date by the extensive observations of M. L. Bhatia on the nephridia and "funnels" of the Indian leech (*Quart. Journ. Micros. Sci.*, 1938, 81, Pt. I, Dec. 1938). Though *Hirudinaria* resembles the European leech *Hirudo* which is described in numerous text-books on Zoology, the true detailed structure and interpretation

of the functions of the various organs are not known conclusively. There are 17 pairs of nephridia in *Hirudinaria*, each consisting of the initial, the apical, the inner and the main lobes, and the vesicle and its duct. The cells of the different lobes form intracellular canals forming a network through the nephridium. The vesicle is a non-contractile bag; it is formed as an epidermal ingrowth during development and later acquires a connection with the nephridium proper. Remarkable ciliated structures called "funnels" occur in association with the nephridium in all the segments except the first six. These have no connexion with the nephridium in the adult, but in the embryo the funnel is a solid mass of cells continuous with the nephridium. The "funnel" is not a degenerate structure as was supposed by many previous workers. Its structure really reveals a large number of smaller funnels opening into a central reservoir. The reservoir is the seat of the manufacture of corpuscles which are thrown out through the funnels into the surrounding perinephrostomial sinus.

* * *

Hyderabad Geological Survey.—The latest number of the *Journal*, Hyderabad Geological Survey (Vol. III, Pt. 2), which has been just published, contains six reports embodying the work done by the several officers of the Survey during the last year. Messrs. L. S. Krishna Murthi and H. S. Krishna Murthi contribute a Note on the Test Bore-holes for the investigation of brine along the Sarjapur Nullah, Raichur District—a locality where a large number of salt works are already in existence producing a considerable percentage of good edible salt, and which also affords quick and easy transporting facilities, being situated on the main road to Raichur. Dealing with another aspect of economic geology in the State, is the paper by the late Capt. L. Munn and Dr. C. Mahadevan, regarding the possibility of making Portland Cement in the vicinity of the proposed dam site across the Kistna in Nalgonda District, Wazirabad limestone area, and at Macherla, Guruzala Taluk, Guntur District. There is also a valuable Note on the Marble deposits near Yellandu in Warangal District, by Mr. Syed Kazim and Dr. C. Mahadevan, in which the authors have given an account of the white, yellow and grey marbles seen about four miles north of Yellandu and have also gone into the question of whether suitable quality of marble is available to be worked, and if so, what would be the quantity available in the area where quarrying operations are under contemplation.

Among the other papers published in the *Journal*, may be mentioned (i) Notes on Deccan trap in parts of Gulbarga and Osmanabad Districts, by Dr. C. Mahadevan and Mr. L. S. Krishna Murthi, and (ii) Correlation of some acid members with the auriferous quartz veins in association with Dharwar formations in the western portion of the Raichur Doab, by Mr. S. K. Mukherjee.

The contents of the *Journal* constitute an impressive record of the varied activities of the Hyderabad State Geological Survey Department, and the general get-up of the publication is quite good.

* * *

Metal-Mining Enterprise which formed the subject of the Warington Smyth Memorial Lecture, delivered sometime back, by Professor S. J. Truscott, at the Royal School of Mines, London, has been published as a booklet ("Metal-Mining Enterprise" by S. J. Truscott. Warington Smyth Memorial Lecture, 1938, Macmillan & Company, London, 1938, pp. 38. Price 1*sh.*). The theme of the lecture forms, mainly, a brief review of the progressive use which man has made of the metals from the early times to the present day.

The lecturer states that the bright colours of the metals, like the glittering yellow of the pellets of alluvial gold and the bright red of heavy native copper, caught the attention of the early man who, discovering some of the physical properties of these metals, used them for his needs; gold as an ornament, and copper for his implements. Later, he seems to have realised that copper when heated was more pliable than the cold metal as found in nature, and on melting, different pieces of copper could be welded together to any required mass. A knowledge of these properties of the metal led to its wide use at this early period which may be called the Copper Age. In regions where some tinstone was associated with copper, an accidental mixture of the former along with molten copper led to the chance discovery of the useful alloy, which we now know as Bronze. The alloy being found better than copper, was then largely used during the period, known as Bronze Age, which came to an end some 4,000 years back. Some time after, about 3,000–4,000 years ago, the production of iron from its ores was discovered, and this gave rise to the Iron Age which has become eventually the present Steel Age. Silver and lead are also stated to have been in use during the ancient periods.

Though all these metals were used by the early man and their practical use was extended for different purposes by the succeeding generations, yet the art of metallurgy developed rather slowly till the end of the nineteenth century, since when the progress has been rapid. After this introductory account of the progressive use of metals the lecturer gives some statistical figures showing the rate of increase of production of the several metals, within the past one hundred years, including nickel and aluminium which have come into general use within this present century. The progress of civilisation has created greater need for the metals, and the demand for them is at present much greater than that for *consumable* goods, like vegetable and animal products; and the lecturer thinks that this demand for metals will continue to increase though at a slower rate.

The lecturer then proceeds to a consideration of the price of metals in relation to their cost of production, demand, international control of markets, etc., Metal-mining enterprise is a risky and speculative venture, and the real worth of any metalliferous deposit depends

upon several fluctuating factors. A metalliferous deposit which may be regarded as practically useless at one time, may attain a considerable importance at another. Huge mechanical appliances for breaking and handling large masses of ore bodies, and improved methods of ore concentration by flotation have brought down the cost of operation considerably in large-scale metal-mining enterprises. The extensive use and the wider application of some metals in modern industries have given an added impetus for their large-scale mining and utilisation. Of such, aluminium and magnesium may be mentioned. The lecturer surmises that in days to come suitable methods may be devised to extract economically aluminium from the common clay, and magnesium, from the largely available deposits of dolomites, when even these common materials may become of considerable value. Similarly many other metals like beryllium, platinum, etc., which are so very rare and difficult to get now may be produced in larger quantities considerably cheaper.

The lecturer has dealt with his subject in a masterly way and those who desire some general information on the present status of metal-mining as a financial enterprise will find the book to be of absorbing interest.

B. RAMA RAO.

* * *

Grasses of Assam.—A list of the known grasses of Assam is given in a publication just brought out by the Forest Research Institute, Dehra Dun, in its *Indian Forest Records*, New Series (Botany).

The importance of the study of grass has been recognised in many parts of the world. Unfortunately, India has lagged behind. The present work, therefore, in which details are given of the grass resources of Assam and a number of grasses new to science are described, marks an important advance in the study of the subject.

Assam, with its tropical temperature, its abundant rainfall and its copious supply of underground water, presents all the essentials of a forest climate as understood by ecologists. The climax vegetation of the Province is, therefore, taken to be a tall forest of evergreen trees.

From very early days, however, a large portion of the Assam plains has been covered by a savannah of tall coarse grasses, which are not relished by cattle; but cattle will eat them in default of anything else. The young leaves and stems, which are sent up by the underground rhizome at the close of the annual fires, are acceptable and are greedily eaten by cattle. Hence the practice of herdsmen is to fire the savannah as early as possible in order to induce the appearance of the tender shoots.

The tall grasses are broken down and each new shoot is browsed off as soon as it appears. Palatable grasses may appear if the locality is favourably placed but they are selectively grazed and are soon eliminated.

At the same time, important changes are taking place in the upper layers of the soil. They are impacted by the hooves of the cattle and the soil becomes drier owing to the removal of the heavy vegetation. The stage is now set for the appearance of deep-rooted perennials which make no far-reaching demands upon the factors of the habitat, and perennials which possess special adaptations which enable them to survive in the face of heavy grazing. Unless new arrivals are adapted to withstand continual browsing they cannot survive, because any erect grass is immediately eaten to the ground.

Therefore the elements required by a plant which has any expectations of survival in closely-grazed pasture are that it must be (1) protected in some way that enables it to use its green parts for photosynthesis, (2) a species which possess an efficient means for the dispersal of its seeds and (3) able to adapt itself to very diverse edaphic conditions.

* * *

Atmospheric Electricity.—A scientific note of the Indian Meteorological Department (Vol. VII, No. 79) by Mr. S. M. Mukherji discusses the results of atmospheric electric observations made at the Colaba Observatory during the period July 1935 to August 1936.

It has long been known that in fair weather, the earth's surface has a charge of negative electricity and that near the ground, the electric potential increases with height at the rate of about 100 volts per metre.

The presence in air of electrified particles or ions causes a small conductivity. The positive ions move towards the side of decreasing potential and *vice versa* causing an "air-earth current".

These quantities are never steady but change with meteorological conditions. During the cold season in Bombay, for example, the potential gradient is very large in the early mornings but decreases in the afternoons. The conductivity changes are in the opposite direction. These changes depend mainly on the presence of haze or fog in the atmosphere.

Of the few systematic observations of these quantities made in India, the earliest observations were those taken at Simla by Simpson in 1910.

In 1930 a small room in the northeast corner of the grounds of the Colaba Observatory, Bombay, was set apart for atmospheric electric observations. For measurements of potential gradient, a radium spiral collector was installed, projecting outside the room through a hole in the western wall at a height of 170 cm. above the ground. Normally the distance between the radium spiral and the wall was kept at 40 cm. but this was altered suitably if any abnormalities in potential gradient were expected. It was clear at the very outset that there were two types of variation of the potential gradient, one characteristic of the southwest monsoon and the other of the dry monsoons. In 1936, therefore, the observations of potential gradient were supplemented by those of atmospheric electric conductivity. From the potential gradient and the conductivity it is possible to calculate in a simple manner the small electric current that flows from the atmosphere to the earth or *vice versa*.

The mean monthly potential gradient has been found by Mr. Mukherji to be maximum in mid-winter and minimum in May. The

conductivity varies roughly inversely to the potential gradient.

The average value of the potential gradient at Bombay was 150 volts metre and conductivity $2{\cdot}5 \times 10^{-4}$ electrostatic units and of air-earth current $5{\cdot}9 \times 10^{-7}$ electrostatic units or $2{\cdot}0 \times 10^{-16}$ amperes per square centimetre of the earth's surface.

* * *

Toxic Gases in Industry.—The Department of Scientific and Industrial Research has issued two further leaflets in the series describing standard methods for the detection of poisonous gases produced in industrial processes. These deal with sulphur dioxide and benzene vapour respectively. (Leaflets Nos. 3 and 4, H. M. Stationery Office, London.)

A concentration by volume of one part of sulphur dioxide in 2,000 is dangerous for even short exposures and one part in 100,000 is the maximum concentration allowable for several hours' exposure. The standard method developed for the detection of this gas depends on drawing a sample of the atmosphere by a hand-pump through test-paper treated with starch and potassium iodate to which potassium iodide has been added. The test-paper becomes stained a brownish colour and the concentration is determined by comparing the stains with a standard colour chart supplied with the leaflet. Concentrations down to one part in 250,000 can be estimated by making not more than ten strokes with the hand-pump. Complete instructions for carrying out the test are given in the leaflet.

In high concentrations benzene vapour acts as a narcotic (acute poisoning). In low concentrations over a prolonged period, it affects the blood and the blood-forming organs of the body (chronic poisoning). Individual susceptibility is well recognised, women and young persons being particularly liable to suffer from chronic poisoning.

Analyses of air in factories where poisoning has occurred give values ranging from 1 in 200 to 1 in 500 parts of benzene.

The chemical test recommended in the leaflet is capable of detecting concentrations down to 1 part in 10,000. The test involves the absorption of benzene vapour in concentrated sulphuric acid containing a trace of formaldehyde. An orange brown colour is produced, even traces of benzene being sufficient for this result. The test is carried out by drawing a sample of the atmosphere under test through a tube containing the reagent by means of a hand-pump of definite capacity, and determining the number of strokes required to produce a certain standard depth of colour. From the number of strokes of the pump required to produce the standard colour, the concentration of benzene vapour present is obtained by reference to the table given in the detailed instructions in the leaflet.

* * *

Fibre from Willow Bark.—The latest *Bulletin* of the Indian Central Jute Committee (No. II, February 1939), gives some details regarding a German patent for breaking up willow bark. "Tannic acid is first extracted from the peeled bark by means of water, after which the bark is boiled for several hours at a pressure of 1 to 3 atmospheres in a 3 to 4 per cent. solution of caustic soda or sodium sulphate. It is then treated with a mixture of about 1 part sulphurous acid, 3 parts hydrochloric acid, and 10 parts water. The fibre produced in this way is specially well adopted for mixing with flax, wool and jute leading to the production of a fabric with new and valuable properties."

* * *

Unification of Pharmacopœiæ.—The potential value of the creation of a limited international pharmacopœiæ has long been realised by medical men and is frequently brought home to the individual patient by the difficulty he experiences in getting his prescriptions made up when abroad. The same problem exists with regard to the treatment of ships' crews calling at different ports and the replenishment of ships' medical chests.

From the academic point of view, the existing variations in the strengths and composition of medicinal preparations in different national pharmacopœiæ add an unnecessary complication to the investigation of the comparative results in drug therapy of the same disease in different countries, and further tend to prevent the adoption of new methods of treatment by a country, even where these have proved valuable elsewhere.

Apart from the view of the practitioner, consideration must also be given to the manufacturer who, from one country, is supplying large quantities of drugs to the international market. The varying standards as to strength and particularly as to purity at present existing make it essential for a producer, either to limit his sales to his own country, or to manufacture a special preparation of the same drug for each country to which he is exporting.

The field of possible unification of pharmacopœiæ had already been explored by an International Conference, meeting at Brussels in 1925, the outcome being a Convention creating an International Secretariat, under the Belgian Government. In addition, the International Pharmaceutical Federation had worked along similar lines. A further step forward was taken in 1937, when, after agreement with the Belgian Government and in *liaison* with the International Pharmaceutical Federation, the Health Organisation set up a Technical Commission of Pharmacopœial Experts. This Commission met in Geneva during 1938 and prepared a programme of studies, including the selection of suitable drugs for examination.

The Commission further considered and adopted standard forms of monograph for use in preparing the drafts, and decided to prepare general descriptions of reagents and analytical procedures and statements of other general principles for the unification of monographs. The preparation of a report on maximum doses and on the possibility of defining average doses was entrusted to two members of the Commission.

Finally, the members agreed to prepare a number of draft monographs on various drugs, sixty of which have already been received. The monographs will be subsequently considered at a meeting of the Commission in May

1939, when the final form will be discussed and approved, and will then be forwarded to the Permanent Secretariat in Brussels for circulation amongst the signatory countries of the Agreement, with a view to their ultimate adoption and final incorporation into a limited international pharmacopœia.—(*Chronicle of the Health Organisation*, League of Nations, *February* 1, 1939.)

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League of Nations.—The latest Bulletin of the Health Organisation of the League of Nations (Vol. VII, No. 5), contains information concerning the activities of the Organisation from August to October 1938, and is specially devoted to the question of biological standardisation.

This number reproduces an important report on the meeting of the serologists of the Permanent Commission on Biological Standardisation held at Paris in October 1938. The report is accompanied by a number of annexes relating to tetanus antitoxin, anti-snake venom serum and gas gangrene anti-toxins. The volume also contains studies on the international standard of vitamin B, and the Report on the Third International Conference on the Standardisation of Hormones, held at Geneva in August 1938.

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At a Symposium on Food and Drug Adulteration held under the joint auspices of the **Association of Technologists, Mysore**, and the **Institute of Chemistry of Great Britain & Ireland** (Indian Section), under the presidency of Sastravaidyapravina Dr. S. Subba Rao, B.A., M.B.B.S., M.R.C.S., Senior Surgeon with the Government of Mysore (Retd.), on Sunday, the 12th March 1939, in the Mayo Hall, C. &. M. Station, Bangalore, the following resolution moved from the Chair, and seconded by Dr. L. R. Govardhan, Health Officer, C. &. M. Station Municipality, was adopted:

> "This meeting of the Association of Technologists, Mysore, the Institute of Chemistry of Great Britain and Ireland (Indian Section) and other scientists and public health authorities is of opinion, that in view of the widespread prevalence of adulteration of foods and drugs in this country, and the absence of effective methods of controlling it, immediate steps should be taken by the governments and public bodies concerned, to (1) introduce suitable standards for the various foods and drugs; (2) introduce suitable legislation to secure more effective control; and (3) appoint public analysts and devise other effective machinery for the detection and prevention of adulteration.
>
> It is suggested that a committee may be appointed to go into the question in Mysore State and representatives may be included from the Association of Technologists and the Institute of Chemistry".

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Indian Zoological Society.—The inaugural meeting of the Indian Zoological Society was held on Saturday, the 7th January 1939, at 3 P.M. in the Zoological Laboratory of the Government College, Lahore. Dr. B. L. Bhatia presided.

The President read out some of the letters received from the members of the Organisation Committee. He reported that 82 zoologists had joined the Society as Foundation Fellows in response to the circular letter issued by him.

Dr. Bhatia then placed before the meeting the draft constitution of the Society which had been prepared by the Organising Committee and this was accepted with a few amendments.

The following Office-bearers were elected:—PRESIDENT: Dr. B. Prashad (*Calcutta*); VICE-PRESIDENT: K. B. Mohd. Afzal Hussain (*Lahore*); SECRETARY: Dr. H. K. Mookerjee (*Calcutta*); and BUSINESS MANAGER OF THE JOURNAL; Dr. B. L. Bhatia (*Lahore*).

Fifteen names were then duly proposed and seconded for election as Ordinary Members of the Council, and the following seven were elected by ballot:—Prof. R. Gopala Aiyar (*Madras*), Prof. B. K. Das (*Hyderabad*), Prof. A. B. Misra (*Benares*), Prof. C. R. Narayan Rao (*Bangalore*), Dr. Hamid Khan (*Lyallpur*), Mr. Inayat Ali Khan (*Aligarh*), and Mr. Guran Lal Arora (*Lahore*).

Lahore was selected as the Headquarter of the Society.

* * *

Society of Biological Chemists, India.—The Ninth Annual General Meeting of the Society of Biological Chemists, India, was held at 2-30 P.M., on Saturday, 7th January, in the University Hall, Lahore. In the unavoidable absence of the President Sir U. N. Brahmachari, Dr. S. S. Aiyar took the Chair.

The annual report and accounts of the Society were presented by the Secretaries and adopted.

The following were elected Office-bearers for the year 1939:—

President: Sir Upendranath Brahmachari; *Vice-Presidents*: Dr. G. J. Fowler, Rao Bahadur B. Viswa Nath, Lt.-Col. S. L. Bhatia and Mr. R. C. Srivastava; *Hon. Secretaries*: Dr. C. N. Acharya and Mr. B. H. Iyer.

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Benares Hindu University.—Mr. S. Ram Mohan Rao, M.Sc., who carried on researches for four years under Professor A. B. Misra on the *Coccidæ* has been awarded the D.Sc. degree by the Benares Hindu University on the recommendations of Prof. R. Newstead, F.R.S., of the Liverpool University and Mr. F. Laing of the British Museum (Natural History Section) in London.

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Dr. A. B. Misra, Professor of Zoology in the Benares Hindu University, was elected President of Section 3(A), dealing with Insect Morphology, Physiology and Embriology at the VII International Entomological Congress recently held in Berlin.

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Dr. C. G. Pandit, Director, King Institute, Guindy, has been awarded the **Minto Medal** for the year 1938 in recognition of his work on virus diseases. The Medal, which is of the value of Rs. 500, is awarded annually for "distinguished work in tropical medicine by an Indian".

Third All-India Obstetric and Gynaecological Congress.—The third All-India Obstetric and Gynæcological Congress will be held in Calcutta during December 1939. The exact date will be notified at a later date. The chief subjects selected for discussion are:—

(1) Functional Uterine Hemorrhage;
(2) Anemia of Pregnancy; and
(3) Maternity and Child Welfare.

Further informations can be obtained from the Secretary, Bengal Obstetric and Gynæcological Society, Calcutta Medical Club House, 91-B, Chittaranjan Avenue, Calcutta.

* * *

Lady Tata Memorial Trust.—Applications are invited for five scientific scholarships of the value of Rs. 150 each for the year 1939–40.

The scholarships are open to men and women and will be tenable for a period of twelve months commencing from the 1st July 1939. Any or all the scholarships may be extended for a further period of twelve months within the discretion of the Trustees. All old scholars who desire renewal should re-apply.

Applicants, who must be of Indian nationality, must be Graduates in Medicine or Science of a recognised University. They must undertake to work whole-time and will be debarred from private practice. In the duration of the period of his scholarship or award, the recipient of the benefit shall devote himself to the work before him to the entire satisfaction of the Trustees, who reserve the right to withdraw payment on the recommendation of the Advisory Committee.

The subject of scientific investigation which they may select must have a bearing directly or indirectly on the alleviation of human suffering by disease.

Applications must be forwarded through the Director of a recognised Research Institute or Laboratory where the candidate proposes to work, and must be accompanied by a letter from the Director stating that he has critically examined the details of the proposed research, that he approves of the general plan and that he is willing, as far as possible, to guide and direct the investigation and give laboratory facilities.

Applications must give (a) a short resume on the subject indicating present state of knowledge and (b) details of the proposed research, indicating (i) the methods intended to be employed, (ii) previous experience in the use of these methods and (iii) the experiments to be carried out.

Applications, which must be typed, must give full particulars in the order indicated above and must be addressed to the Secretary, The Lady Tata Memorial Trust, "Bombay House," Bruce Street, Fort, Bombay, so as to reach him not later than 7th April 1939.

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Government of India: Industrial Research Council.—The Government of India offer the following prizes for the papers dealing with researches of industrial importance:

1st Prize of	Rs.	1,000
2 Prizes of	,,	500 each
2 ,, ,,	,,	250 ,,
3 ,, ,,	,,	150 ,,

Particulars of the terms of the competition and entry forms may be obtained free of cost on application to the Director, Industrial Research Bureau, Imperial Secretariat, New Delhi. Entries will be accepted only on the official forms provided.

Papers must be submitted not later than the 1st June 1939.

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Deutsche Akademie.—On the occasion of its tenth jubilee year the Indian Institute of the "Deutsche Akademie" in connection with the study group "Das Ahnenerbe" has selected in October 1938 the following subject for a competition: *"Symbols in India, their meaning, historical development and present position."*

This competition is open only to Indian scholars who have already graduated and completed their study.

All papers must be submitted on or before the first of April 1940.

The first prize is a scholarship for one year in a German university town including the costs for the journey from India to Germany and back.

The second prize is a scholarship for one year in a German university town but exclusive of the costs of the journey.

The third prize is a scholarship in a German university town for half a year and exclusive of the costs of the journey.

The winner of the first prize will receive a monthly stipend of RM. 300—during his stay in Germany. The winners of the second and third prize will receive a monthly stipend of RM. 200—each.

All winners will receive in addition the journal of the "Deutsche Akademie" and one of the journals of the study group "Das Ahnenerbe" according to their own choice free for three years.

The India Institute of the "Deutsche Akademie" acquires the right to print and publish any of the prize winning papers. The printed papers will bear a notice showing them to be the prize winners in the competition of the India Institute of the "Deutsche Akademie" and of the study group "Das Ahnenerbe".

Papers which have not been awarded a prize will be returned. The Committee however cannot undertake any responsibility with regard to the reading and returning of any paper that may be submitted to them.

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International Centre for the Identification of Salmonellae.—In pursuance of the recommendation adopted by the International Association of Microbiology, an International Centre for the identification of Salmonella Strains has been set up, thanks to a grant from the Commonwealth Fund, at the State Serum Institute, Copenhagen, under the direction of Dr. F. Kauffmann. With a view to facilitating the serological identification of Salmonellæ in all countries, this centre is willing to distribute the necessary immune sera and standard cultures free of charge, and to study any aberrant strains sent to it. It also proposes to stimulate the establishment, in every country, of national centres equipped for the identification of Salmonella strains, which would thus be in a position to meet the requests for agglutinating sera made by scientific workers in the country concerned.

ACADEMIES AND SOCIETIES

Indian Academy of Sciences:

February 1939. SECTION A.—(Miss) S. Pankajam: *On Symmetric Functions of m Symmetric Functions in a Boolean Algebra.* G. Abdulla and Lal Bahadur: *On a Problem of Arrangements.* S. Chowla: *A New Solution of the 10-21 Problem.* A. E. Brodskii, A. M. Sack and L. V. Kortchagin: *The Raman Spectra of liquid solutions.*—The additivity of the Raman Spectra in mixtures of $AsCl_3$, $SbCl_3$ and PCl_3 with different solvents, has been investigated. N. M. Phillip: *Adiabatic and Isothermal Compressibilities of liquids.*—The adiabatic compressibility, variation of specific volume with temperature, and specific heat at constant pressure have been measured for 24 liquids after careful purification. The data have been applied to the data on light-scattering, and good agreement found. P. B. Rama Murty and T. R. Seshadri: *Chemical composition of* Vitis quadrangularis *(Wall.).*—The plant contains a high percentage of mineral matter, and Vitamin C. As a source of carotene it occupies a middle place. B. R. Venkataraman: *On the inverses of a circle with respect to a tetrad of fixed circles and their orthogonal tetrad.* S. Rangaswami, P. Suryaprakasa Row and T. R. Seshadri: *Pigments of Cotton Flowers, Part VI.—Methylation of Herbacetin.* B. R. Seth: *Potential solutions near an angular point.* K. S. K. Iyengar: *On a problem related to the Cauchy-Maclaurin Integral Test.* S. S. Bhatnagar, P. L. Kapur and A. Hussain: *Studies in the properties of Bivalent Metal Oleates, Part I.*—A study of physical properties such as solubility, molecular complexity, viscosity, surface tension, etc., shows that whereas zinc oleate may be regarded as a gel, magnesium oleate behaves more like a colloidal electrolyte. A. Narasinga Rao: *Studies in Turbine Geometry, III—The non-oriented line element in two-dimensional mobius geometry.*

February 1939. SECTION B.—Rama Nagina Singh: *The Myxophyceæ of the United Provinces, India, IV*—deals with some of Myxophyceæ that have not been recorded from the U.P. Jagjiwan Singh: *A Contribution to our knowledge of the Indian Soil Actinomycetes.*—The actinomycetes do not show any marked seasonal variation in population. V. Puri: *Studies in the order parietales, II.—A Contribution to the Morphology of* Garcinia livingstonii *T Anders.* M. C. Cherian and Mohamed Basheer: Tetrastichus sokolowskii *Kurdj* (Family Eulophidæ)—*A Larval Parasite of* Plutella maculipennis *in South India.*—The habits and life-history of the parasite are described. H. S. Rao: *Cuticular studies of Magnoliales.*—The Magnoliales have not been directly derived from Bennettitales, and synthetic types combining the characters of the Cycadales, the other haplocheile gymnosperms and the angiosperms are to be found in this small group.

Indian Association for the Cultivation of Science (Proceedings):

December 1938.—A. C. Banerji and P. L. Bhatnagar: *On the Intensity of Ionisation in the Earth's Atmosphere.* A. Balankeswara Rao: *The Spectrum of Argon IV.* L. Sibaiya: *On the excitation of Chladni Figures.* S. K. Banerji: *On the Interchange of Electricity between solids, liquids and gases in mechanical actions.* Mohinimohan Ghosh: *Dynamics of the pianoforte string and the hammer, Part II.* S. K. Mitra, J. N. Dhar and S. P. Ghosh: *The lower ionosphere.*

Indian Chemical Society:

November 1938.—S. S. Bhatnagar, P. L. Kapur and Mahbub Shah Hashmi: *Phototropy and photochemical isomerism from the magnetic Standpoint.* N. R. Dhar and S. K. Mukerji: *Denitrification in sunlight and its retardation, Part IV.* W. V. Sundara Rao, P. V. Krishnamurti and G. Gopala Rao, *Mechanism of the Micro-biological oxidation of ammonia. Part I—Formation of intermediate products.* Jamiat V. Lakhani and Rustom P. Daroga: *The determination of the parachors of inorganic salts in solutions. Part III—The parachors of some salts of magnesium, strontium and barium, and the atomic parachor of the above elements and radium.* R. Chatterjee: *Oxalenediamidoxime. Part I—Estimation of nickel.* S. C. Ganguly: *On the estimation of fumaric and maleic acids.* Balwant Singh: *Note on oxidation of ferrous iron with potassium iodate.*

Meteorological Office Colloquium, Poona:

February 3, 1939.—N. K. Sur: *Lange's Radio Meteorograph. February* 14, 1939.—K. R. Ramanathan: *The Earth's Magnetism and the Upper Atmosphere.*

Fourthcoming Event

April 7-8, 1939.—A convention of Technologists and a Symposium on Materials of Construction for the Chemical Industry will be held at Bhadravati under the joint auspices of the *Association of Technologists, Mysore* and the *Technical Association, Bhadravati.* The convention will be opened by Rajasevaprasakta A. V. Ramanathan, Chairman, Mysore Iron and Steel Works. Sir C. V. Raman, Kt., F.R.S., N.L., will preside over the Symposium.

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